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Report of Investigations No. 147

BRACHIOPODS FROM THE MAXVILLE LIMESTONE (MISSISSIPPIAN) OF OHIO

by

Richard D. Hoare
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Columbus
2003

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Cover illustration: Brachial view of *Anthracospirifer leidyi* (Norwood & Pratten). See plate 4.

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ABSTRACT

Brachiopods are the most common and better preserved of the larger invertebrate fossils in the Maxville Limestone (Mississippian, Chesterian) in Ohio. Among the 14 taxa recognized, *Diaphragmus cestriensis* (Worthen), *Composita subquadrata* (Hall), and *Girtyella indianaensis* (Girty) are the most common. *Pugnoides macgordoni* n. sp., *Torynifer setigera* (Hall), *Lingula* sp., and *Buxtonia*? sp. are recognized for the first time in the Maxville fauna.

The presence of *Martinia contracta* (Meek & Worthen) and a large, globose, gerontic specimen of *Orthotetes kaskaskiensis* (McChesney) may correlate part of the Maxville Limestone with the Little Stone Gap Member of the Hinton Formation in the Appalachian region (*Orthotetes subglobosus-Martinia contracta* Assemblage Zone of Henry and Gordon, 1992).

Epifauna preserved on the brachiopods consists of the worm tubes *Cornulites* and *Spirorbis* (the latter being most common), trepostomate bryozoans, and brachiopod spat. The worm tubes are commonly close to the anterior or lateral margins of the host and have their apertures directed anteriorly. Spat were found only on the brachial valve of *Diaphragmus cestriensis* (Worthen).

INTRODUCTION

LOCATION AND SCOPE OF STUDY

The Maxville Limestone, named by Andrews (1870), extends from Muskingum County, Ohio, southward to the Kentucky side of the Ohio River south of Scioto County, Ohio (Morse, 1910, p. 9). It is best exposed, mainly in quarries and railroad cuts, in the northern portion of the area; in the rest of its extent it is covered except for a few small patches in southern Ohio. Most of the specimens studied were collected from 17 localities in Muskingum, Perry, and Hocking Counties, Ohio (fig. 1; Appendix). A few specimens from the repository at the Orton Museum, The Ohio State University, contained no locality information on the labels.

The purpose of the study was to (1) update the taxonomy and redescribe previously known species of brachiopods and bring attention to species new to the fauna; (2) describe epifaunal elements found attached to the shells; and, (3) refine the stratigraphic correlations with known faunas from adjoining depositional regions.

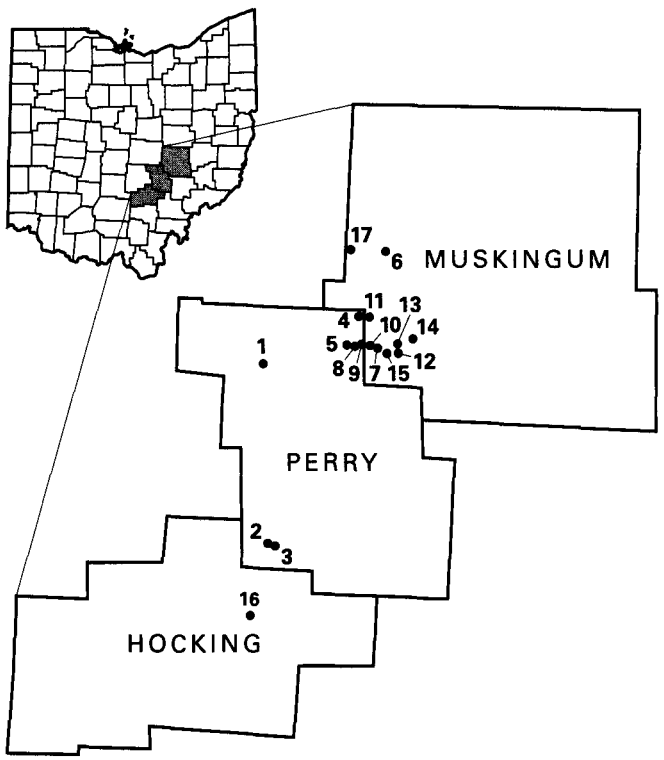

FIGURE 1.—Map showing approximate location of collecting localities of the Maxville Limestone. See Appendix for descriptions of localities.

METHOD OF INVESTIGATION

A large collection of Maxville Limestone invertebrates, made by the late M. T. Sturgeon and his students, came from Ohio University. A second large collection, made by the late A. S. Horowitz of Indiana University and K. B. Bork of Denison University, was made available for study. Several specimens in the collections at The Ohio State University also were available for study. Further collecting by the author and his family added to the total fauna from several localities. Of the faunas collected by Whitfield (1891, 1893) and Morse (1910, 1911), only a single brachiopod, *Athyris subquadrata* (illustrated by Whitfield, 1893, pl. 10, figs. 1-3) has been located in the collections at the University of California, Berkeley (specimen no. 2214/3424) (Peck and McFarland, 1954).

Preparation of specimens for description and illustration was often a tedious process. The calcareous matrix adhering to the shell surface was difficult to remove with a vibratool and fine picking needles. Serial sections were cut with a Croft Serial Grinder using 600 carborundum grit. Specimens were coated with India ink and magnesium oxide smoke for photography.

All illustrated and measured specimens have been placed in the repository of the Orton Museum at The Ohio

State University (OSU). Additional specimens of many of the species are in the collections of the Department of Geology, Bowling Green State University.

PREVIOUS INVESTIGATIONS

Whitfield (1891, 1893) first described portions of the fauna of the Maxville Limestone, including several brachiopod species. Morse (1910), in his study of the Maxville Limestone, gave a detailed account of the study of the formation between 1838 and 1906 and listed fauna found at a number of localities. In his 1911 report on the Maxville Limestone, Morse described nine brachiopod species. Weller (1914) mentioned and illustrated one species of brachiopod, *Spirifer pellaensis* n. sp., from the Maxville Limestone in Fayette County, Pennsylvania. The latter is probably *Anthracospirifer leidyi* (Norwood & Pratten) from the Greenbrier Formation.

Other studies on the Maxville fauna include Scatterday (1963) on conodonts, Hoare (1991, 1993) on ostracodes, Hoare and Skipp (1995) on foraminifera and problematica, Hoare and others (1988) on a bivalve color pattern, and Babcock (1996) and Brezinski (1988) on trilobites. A study of the bivalves is in progress.

ACKNOWLEDGMENTS

Many thanks are extended to Royal H. Mapes, Ohio University, and Dale Gnidovec, The Ohio State University, for making numerous specimens available for study. The collections made by the late Alan S. Horowitz, Indiana University, and Kennard B. Bork, Denison University, were given by Horowitz as a gift to the author, which is greatly appreciated. Patrick S. Wurm, The Ohio State University, was helpful in obtaining reference information. The editing of Merrianne Hackathorn, Ohio Division of Geological Survey, was most beneficial in finalizing the manuscript.

STRATIGRAPHIC AGE AND FOSSIL OCCURRENCE

The Maxville Limestone in the study area ranges from massive gray layers to more thinly bedded layers to nodular limestone and shale. A sandstone zone is present in the lower portion of the formation, and at least two black shale zones are sporadic in occurrence (fig. 2). Uttley (1974) presented a detailed study of the stratigraphy of the Maxville.

Scatterday (1963), on the basis of conodonts, and Horowitz (1969), using brachiopods, cephalopods, and crinoids, assigned the upper portion of the Maxville to the Chesterian. The foraminiferal study of Hoare and Skipp (1995) supported an early Chesterian age for the upper Maxville. Henry and Gordon (1992), in their study of the Upper Mississippian-Lower Pennsylvanian faunas in Virginia and West Virginia, established three brachiopod assemblage zones. The Maxville brachiopods fall into the *Orthotetes subglobosus-Martinia contracta* zone, which is in the Little Stone Gap Member of the Hinton Formation in the eastern Appalachians and correlates with the upper Fayetteville Shale of the Ozark region and units between

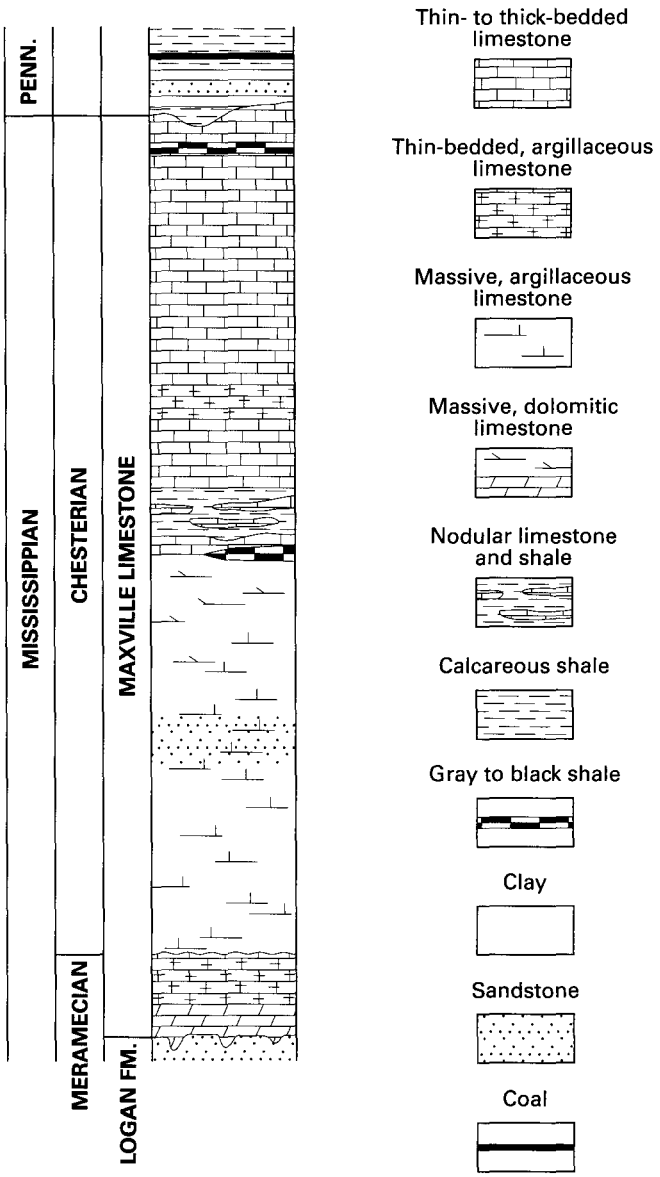

FIGURE 2.—Generalized stratigraphic section of the Maxville Limestone in east-central Ohio (modified in part from Scatterday, 1963, and reprinted by permission of the Paleontological Society).

the Glen Dean and Menard Limestones in the Upper Mississippi Valley region. This correlation places the Maxville in the Namurian "A" substage (Henry and Gordon, 1992).

Most of the specimens were collected from the nodular limestone and shale zone near the middle of the formation. Not only is this zone one of the more fossiliferous portions, but it is also the easiest to extract the fauna from. Specimens have been found in the other limestone layers and in the black shale.

EPIFAUNA

Epifauna was found attached to many of the brachiopod hosts. The most common of these were the calcareous coiled tubes of the worm *Spirorbis* Daudin, 1800 (pl. 1, fig.

1). The presence of these tubes ranges from a single specimen to a dozen or more specimens on a single host shell. They were found attached to specimens of *Composita subquadrata*, *Anthracospirifer leidyi*, *Girtyella indianaensis*, and *Diaphragmus cestriensis*. Although the attachment may take place on any position of the host shell, it is more common near the anterior and lateral margins, typically with the opening of the tube oriented toward the shell margin.

A second type of worm tube, *Cornulites* Schlotheim, 1820, (pl. 1, fig. 2), was found attached to two hosts, *Composita subquadrata* and *Girtyella indianaensis*. In both cases the tubes are located near the anterior margin of the host with the opening directed toward the margin. The occurrence illustrated in figure 2 of plate 1 also seems to show reproduction of the worm, with three smaller tubes extending from the larger, more mature specimen. Several additional occurrences of worm tubes are illustrated on various plates.

Trepostomate bryozoan colonies were found attached to *Composita subquadrata* (pl. 1, fig. 3), commonly as multiple colonies on a host. The growth of a colony on one specimen crosses over the anterior margin, effectively locking the valves together. Whether the epifaunal growth occurred during life or after death of the host is unknown.

One specimen of *Diaphragmus cestriensis* (pl. 1, fig. 4) bears brachiopod spat on the brachial valve. A total of 10 small, immature, and incomplete shells are present scattered over the valve surface. The specimens appear to be brachiopod spat on the basis of their general shape and are some type of productid, probably either *Ovatia* or *Diaphragmus*. In life position of the host specimen, the brachial valve is uppermost and the pedicle valve is partially or completely buried in the substrate. The host may have been alive or dead at time of attachment of the spat.

A specimen of *Ovatia iowaensis* (pl. 2, fig. 19) shows shell repair on the brachial valve. Additional calcareous shell material has been deposited over some type of damage to the shell. What caused the damage is unknown.

The attachment of the epifaunal elements took place because the surface of the host shell provided a favorable surface for their attachment and growth. Only the worm tubes give some evidence of a commensal relationship between the worms and the brachiopod host, the worms benefiting from the currents developed by the host in feeding or explusion of waste products.

SYSTEMATIC PALEONTOLOGY

Genus *Lingula* Bruguière, 1797
Lingula sp.
Pl. 1, fig. 5

Elongate, spatulate shell with broadly convex lateral margins, anterior margin strongly convex; beak marginal; internal features not preserved.

Discussion.—A single poorly preserved pedicle-valve interior of a linguloid is present. It is not complete enough for specific identification, although in shape it resembles specimens from the Bramwell Member of the Bluestone Formation of Virginia illustrated by Henry and Gordon (1992, pl. 4, figs. 1-5) as *Lingula* n. sp. Inarticulate brachiopods have not been previously described from the Maxville Limestone and appear to be rare within the formation. The specimen was found at locality 5.

Repository.—OSU 51051.

Genus *Orthotetes* Fischer de Waldheim, 1829
Orthotetes kaskaskiensis (McChesney, 1859)
Pl. 1, figs. 6-15; pl. 2, figs. 1-4; fig. 3

Orthis kaskaskiensis McChesney, 1859, p. 31.
Streptorhynchus crassus Whitfield, 1891, p. 580, pl. 13, figs. 11, 12; Whitfield, 1893, p. 468, pl. 9, figs. 11, 12.
Derbya kaskaskiensis Hall and Clarke, 1892, pl. 11B, fig. 6.
Derbya crassa Morse, 1911, p. 366, fig. 7.
Orthotetes kaskaskiensis Weller, 1914, p. 77, pl. 6, figs. 1-14.

Shell large, convexi-concave to resupinate; greatest width and thickening near midlength; cardinal margin forms an obtuse angle; lateral margins less convex than rectimarginate anterior margin; hingeline slightly shorter than maximum width; pseudopunctate.

Pedicle valve shallowly convex becoming near planar in late growth stages; beak symmetrical, lacking attachment scar; interarea large, triangular, flat, apsacline; delthyrium narrowly triangular, pseudodeltidium convex, grooved; perideltidial plates narrow; surface parvicostellate with first and second order costellae, 20 per cm measured 2 cm from beak; comarginal growth lines, some pronounced; internally (fig. 3), narrow median septum, becoming higher anteriorly; septum joins dental plates, pseudodeltidium forms small delthyrial chamber; dental plates extend anteriorly separating from median septum.

Brachial valve increasing in convexity during growth; beak covered by chilidium; chilidium convex, grooved medially with central defected transverse grooves around small circular pedicle opening just below margin of pseudodeltidium at all growth stages; interarea narrow, anacline; ornamentation as on pedicle valve; internally (fig. 4), cardinal process (pl. 2, fig. 4) with two lobes with thin median septum, scars on lobes for muscle attachment, and supported by curved socket ridges; low, indistinct median septum posteriorly.

Measurements.—See table 1.

Material studied.—Twenty complete or fragmental specimens from quarry at locality 6.

Discussion.—The illustrations by Whitfield (1891, pl. 43, figs. 11, 12; 1893, pl. 9, figs. 11, 12) and republished by Morse (1911, figs. 7a, b) are in no way indicative of *O. kaskaskiensis*. None of the specimens studied shows a large, flattened attachment area on the pedicle valve, and the brachial view must have been drawn with the shell strongly rotated so that the interarea does not show.

Weller (1914) made no mention of a pedicle opening at the base of the pseudodeltidium. He compared *O. kaskaskiensis* with *O. keokuk* (Hall, 1858), noting that the latter was a larger species attaining a width of 100 mm, having a stronger convexity of the brachial valve, and less elevated and acuteness of the pedicle beak than in *O. kaskaskiensis*. It would appear that his comparison was based, at least in part, on only very mature or gerontic individuals of *O.*

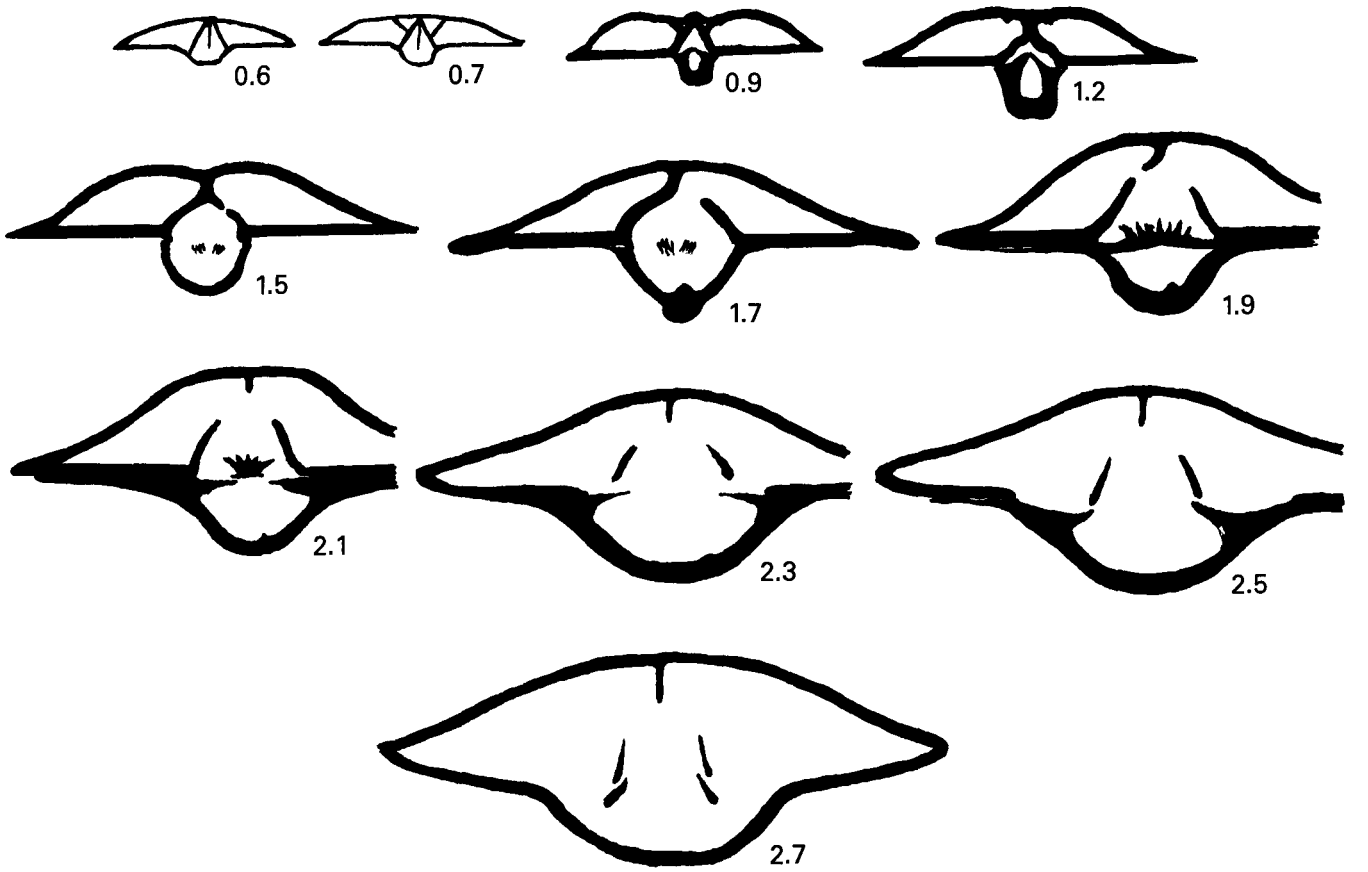

FIGURE 3.—Transverse serial sections of *Orthotetes kaskaskiensis* (McChesney), approximately X2.6, locality 6. Numbers refer to distance in millimeters from ventral beak.

TABLE 1.—*Measurements (in mm) of* Orthotetes kaskaskiensis *(McChesney)*

OSU specimen no.	Length	Width	Thickness
51052	20.7	24.7	9.0
51053	27.5	31.9	14.9
51054	27.9	37.8	11.1
51055	32.4	40.5	15.2
51056	46.4	59.1[1]	25.7

[1]Estimated.

keokuk. Plate 2, figs. 1-3, illustrate a gerontic specimen from the Maxville Limestone that could be mistaken for *O. keokuk*.

Gordon and Henry (1981) and Henry and Gordon (1992) illustrate a number of specimens of *Orthotetes* from Middle and Late Mississippian units in Virginia and West Virginia indicating that most have affinities to *O. kaskaskiensis* but are labeled as new species. One large specimen with a strongly convex brachial valve is assigned to *O. subglobosus* Girty, 1910. The latter may be a gerontic specimen representing one of their new species from the Little Stone Gap Member of the Hinton Formation.

Repository.—OSU 51052-51056.

Genus *Diaphragmus* Girty, 1910
Diaphragmus cestriensis (Worthen, 1860)
Pl. 2, figs. 5-16

Productus cestriensis Worthen, 1860, p. 570; Keyes, 1894, p. 44; Weller, 1897, p. 256, pl. 18, figs. 7-9; Morse, 1911, p. 372, figs. 9a-g.

Productus elegans Whitfield, 1891, p. 581, pl. 13, figs. 15, 16; Whitfield, 1893, p. 469, pl. 9, figs. 15, 16.

Diaphragmus cestriensis Gordon and Henry, 1981, pl. 3, figs. 5-8; Henry and Gordon, 1992, pl. 1, figs. 22, 23, pl. 2, figs. 2, 3.

Small, concavo-convex shell; greatest width anterior to midlength, greatest thickness posterior to midlength; trails in near contact; hingeline shorter than maximum width; pseudopunctate.

Pedicle valve with beak overhanging hingeline; umbo strongly convex; slightly flattened medially, flanks convex; ears small; surface costate, increasing by bifurcation and intercalation, 14 per cm on anterior margin of ventral disc; ears and posterior flanks rugose, rugae crossing viseral disc; spines scattered on surface, two rows of smaller spines on ears, small patches of spines on flanks; fine, closely spaced, comarginal growth lines; internal features not observed.

Brachial valve geniculate, shallowly convex over visceral disc posterior to geniculation; costate and rugose; scat-

tered spines on trail; internally, cardinal process small, inclined dorsally, bilobed, lobes ridged for muscle attachment, supported by dorsal cardinal ridge laterally; trail long, repeated at least 1-2 times; diaphragm lightly developed; median septum low to absent anterior to cardinal process, thin, becoming higher anteriorly; muscle scars lightly developed.

Measurements.—See table 2.

Material studied.—Several hundred specimens from localities 1-7, 10, 13, 14, 17.

Discussion.—*Diaphragmus cestriensis* is one of the most common and geographically widespread taxa of brachiopods in the Maxville Limestone. When specimens are broken from the matrix, they commonly break at the sharp geniculation of the shell and the trails are lost.

Diaphragmus fasciculatus (McChesney, 1859) differs from *D. cestriensis* in having a noticeable sulcus on the pedicle valve and the costae commonly are grouped in bundles or fasicles. Weller (1914, p. 136) included *D. cestriensis* in synonymny with *D. elegans* (Norwood & Pratten, 1855).

Repository.—OSU 51059-51065.

TABLE 2.—*Measurements (in mm) of* Diaphragmus cestriensis *(Worthen)*

OSU specimen no.	Length	Width	Thickness
51059	13.0	15.8	5.6
51060	15.6	16.4	9.7
51061	15.1	17.8	8.3
51062	14.0	15.7	7.9
51063	16.8	20.0	9.8
51064	17.1	18.5	9.9
51065	14.6	16.9	7.7

Genus *Ovatia* Muir-Wood & Cooper, 1960
Ovatia iowaensis new name
Pl. 2, figs. 17-19, 22, 23

Productus ovatus Hall 1858b, p. 674, pl. 24, fig. 1; Hall, 1883, pl. 49, fig. 19; Hall and Clarke, 1892, pl. 18, fig. 19; Keyes 1894, p. 44; Weller, 1914, p. 132, pl. 16, figs. 1-15.

Productus pileiformis McChesney, 1859, p. 40; Whitfield, 1891, p. 582, pl. 13, figs. 13, 14; Whitfield, 1893, p. 470, pl. 9, figs. 13, 14; Girty, 1909, p. 26, pl. 2, fig. 7; Girty, 1911, p. 44, pl. 4, figs. 1, 2; Morse, 1911, p. 370, figs. 8a-c.

Productus laevicostus White, 1860, p. 230; Hall and Whitfield, 1877, p. 266, pl. 5, figs. 7, 8; Keyes, 1894, p. 41, pl. 38, fig. 1; Girty 1899, p. 534, pl. 69, figs. 9a-c; Girty, 1903, p. 284.

Productus prattenianus (= ?*P. laevicostus* White, 1874, p. 17); White, 1877, p. 17.

Shell reaching medium size, concavo-convex; greatest width at or near hinge, greatest thickness posterior to midlength; trails in near contact; body cavity small; pseudopunctate.

Pedicle valve convex; flanks convex; ears large, convex; surface costellate with intercalate first-order costellae present; costellae become irregular in areas of shell damage and to lesser extent around spines; eight coarse rugae on flanks and near ears, becoming fainter in crossing viseral disc; spines scattered irregularly on surface, two rows on ears, length unknown; internal features not observed.

Brachial valve strongly concave with numerous rugae crossing surface; costellate, increasing by bifurcation; no evidence of spines; internal features not observed.

Etymology.—Named for the state of Iowa.

Measurements.—Largest incomplete specimen is 22.5 mm long, 24.4 mm wide, and 11.5 mm thick.

Material studied.—Fourteen specimens from locality 6; one each from localities 5, 8, 9, 11, 12, 17.

Discussion.—Muir-Wood and Cooper (1960, p. 313) discussed the problems related to differentiating *O. ovatus* (Hall, 1858), *O. pileiformis* (McChesney, 1859), and *O. laevicostatus* (White, 1860). Hall's name, *ovatus,* is preoccupied by *Productus ovatus* Pander, 1830, and needed to be renamed, as noted by Muir-Wood & Cooper. Weller (1914, p. 132) and Sutton (1938, p. 558) both listed *pileiformis* and *laevicostatus* as synonyms of *ovatus,* with which I agree. The species is thus herein renamed *O. iowaensis. Ovatia elongata* Muir-Wood & Cooper, 1960, from the Fayetteville Shale of Oklahoma, differs from *O. iowaensis* by having a stronger umbonal convexity and smaller ears.

Repository.—OSU 51068, 51069, 51072, 51073.

Ovatia aff. *O. elongata* Muir-Wood & Cooper, 1960
Pl. 3, figs. 1-3

Ovatia elongata Muir-Wood and Cooper, 1960, p. 312, pl. 114, figs. 1-4, 7, 11, 12; Henry and Gordon, 1992, pl. 1, figs. 17-19, pl. 2, figs. 10-15.

Shell of medium size, concavo-convex, elongate; greatest width near midlength, greatest thickness anterior to umbonal area; body cavity small; pseudopunctate.

Pedicle valve strongly convex posteriorly; flanks steep; ears small; surface costellate with first-order intercalate costellae; coarse rugae on ears and flanks, more subdued across visceral disc; spines not evident except faintly near hingeline; internal features not observed.

Brachial valve not observed.

Measurements.—Most complete specimen is 31.0 mm long, 30.0 mm wide, and 17.5 mm thick.

Material studied.—One specimen from locality 6; three specimens from an unknown locality.

Discussion.—*Ovatia elongata* was described by Muir-Wood and Cooper (1960, p. 312) as having numerous small, thin spines scattered on the shell, although they do not show up in their illustrations. Some of the specimens illustrated by Henry and Gordon (1992) show obvious spines, others do not. The lack of discernible spine bases except for a few near the hingeline of the Maxville specimens leaves some question as to their exact affinity.

The specimens occur in a hard, fine-grained limestone rather than the nodular limestone that the specimens of *O. iowaensis* came from. The specimen illustrated in plate 3, figures 2, 3 has severe shell damage near the center of the pedicle valve.

Repository.—OSU 22909, 51070, 51071.

Genus *Buxtonia* Thomas, 1914
Buxtonia? sp.
Pl. 2, figs. 20, 21

Material studied.—One partial valve from locality 7.

Discussion.—The single poorly preserved specimen of a pedicle valve of a large productid is gently convex, flattened to slightly concave medially, with rounded flanks, and small ears. The costae are rounded with narrower interspaces, 8 per cm near the anterior margin, increasing by intercalation. The ears and flanks are rugose. The rugae extend faintly across the visceral disc. No indicaton of spines is preserved, although irregularities on the costae may indicate swellings associated with spine bases. Poor preservation prevents a specific assignment. *Buxtonia semicirculus* (Sutton and Wagner, 1931) was illustrated from the Pride Shale Member of the Bluestone Formation in West Virginia by Henry and Gordon (1992, pl. 3, fig. 11). The specimen is 31.7 mm long, 34.5 mm wide, and approximately 13.8 mm thick.

Repository.—OSU 51074.

Genus *Pugnoides* Weller, 1910
Pugnoides macgordoni n. sp.
Pl. 3, figs. 4-20; fig. 4

Diagnosis.—Subtriangular shell with 3-4 plications on fold, 2-3 plications in sulcus; crural plates joined.

Shell small, rostrate, subtriangular, with beak overhanging hingeline; greatest width near midlength, greatest thickness near or anterior to midlength; anterior margin strongly plicosulcate; impunctate.

Pedicle valve with shallow sulcus beginning near midlength containing 2-3 subangular plications; 5-7 subangular plications lateral to sulcus diminishing in size laterally; pedicle opening hypothyroid, delthyrium partially closed by deltidial plates; surface smooth with comarginal growth lines; internally (fig. 4), strong dental plates; large teeth.

Brachial valve with fold beginning near or anterior to midlength bearing 3-4 subangular plications; 5-7 plications present laterally; internally (fig. 4), united crural plates forming septalium; opening of septalium with angular plates anteriorly; median septum diminishes in height anteriorly.

Etymology.—Named for the late Mackenzie Gordon, Jr., U.S. Geological Survey, for his extensive study of Paleozoic invertebrates.

Measurements.—See table 3.

Material studied.—Twenty-three specimens from locality 6.

Discussion.—Specimens of *Pugnoides macgordoni* vary considerably in terms of the prominence and number of plications on the fold and sulcus, but this feature appears to be less variable than in *P. ottumwa* (White, 1862) which may have 1-5 plications in the sulcus and 2-5 on the fold according to Weller (1914, p. 144). The latter species is also narrower in form than *P. macgordoni*.

Respository.—Holotype, OSU 51075; paratypes, OSU 51076-51084.

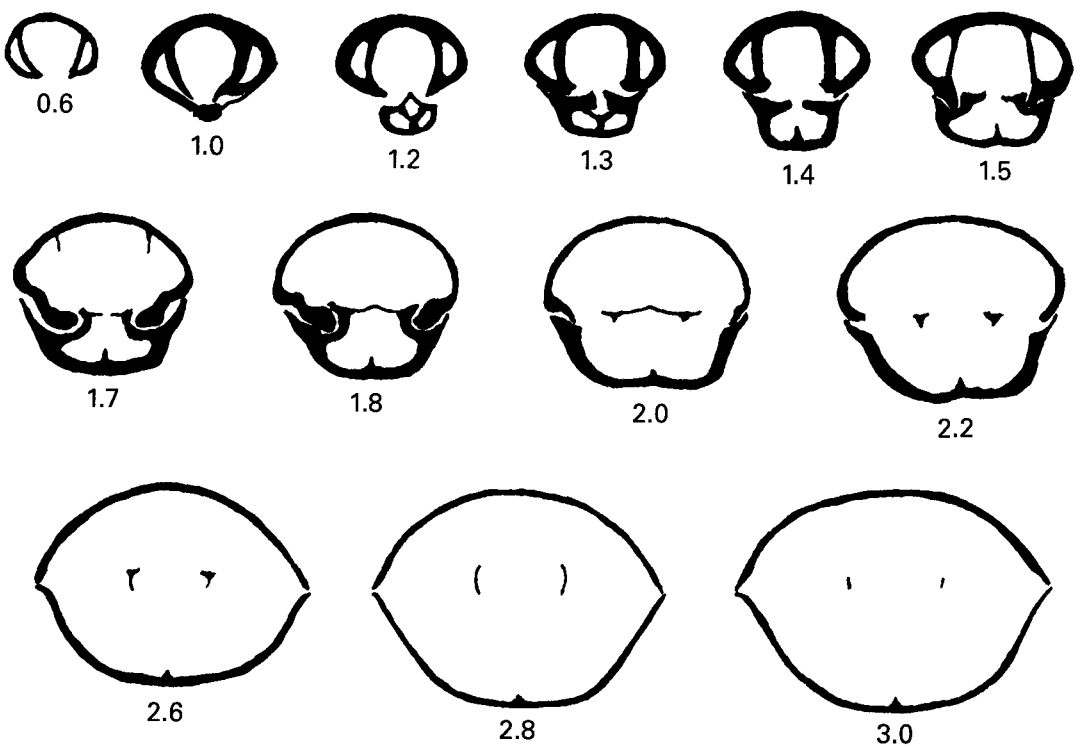

FIGURE 4.—Transverses serial sections of *Pugnoides macgordoni* n. sp., approximately X6.3, locality 6. Numbers refer to distance in millimeters from ventral beak.

TABLE 3.—*Measurements (in mm) of* Pugnoides macgordoni *n. sp.*

OSU specimen no.	Length	Width	Thickness
51075[1]	10.1	9.3	6.2
51076	9.8	10.0	5.9
51077	10.4	9.6	6.5
51078	8.9	8.8	5.6
51079	9.5	9.4	4.9
51080	8.5	9.2	6.0
51081	8.6	8.1	4.8
51082	8.2	8.2	6.0
51083	8.4	8.2	5.0
51084	9.4	9.0	5.1

[1]Holotype.

Genus *Eumetria* Hall, 1864
Eumetria verneuiliana (Hall, 1858)
Pl. 3, figs. 21-23; fig. 5

Terebratula serpentaria Owen, 1852, fig. 13.
Retzia verneuiliana Hall, 1858a, p. 9; Hall, 1858b, p. 657, pl. 23, figs. 1a-d; Walcott, 1884, p. 220, pl. 7, figs. 5, 5a; Keyes, 1894, p. 95.
Eumetria verneuiliana Whitfield, 1882, p. 50, pl. 6, figs. 28-30; Hall, 1883, p. 335, pl. 29, figs. 28-30; Hall and Clarke, 1894, pl. 37, figs. 1-4, 6, 10; Hall and Clarke, 1895, pl. 51, figs. 13-26, 34, 35, pl. 83, figs. 26, 27; Weller, 1897, p. 259; Girty, 1899, p. 560, pl. 68, figs. 12a, b; Weller, 1914, p. 442, pl. 76, figs. 18-24.
Eumetria marcyi? Girty, 1903, p. 303; Girty, 1904, p. 49, pl. 10, figs. 15-17; Beede, 1906, p. 1319, pl. 22, figs. 28-30; Girty, 1911, p. 77, pl. 8, figs. 10; Morse, 1911, p. 386, fig. 14.
Retzia vera Hall, 1858b, p. 704, pl. 27, fig. 3a; Hall and Clarke, 1894, pl. 37, figs. 8, 12; Keyes, 1894, p. 95; Hall and Clarke, 1895, pl. 51, figs. 36, 37; Bassler, 1909, pl. 29, figs. 4, 5; Weller, 1914, p. 444, pl. 76, figs. 13-17.
Retzia vera var. *costata* Hall, 1858b, p. 704, pl. 27, figs. 3a, b; Hall and Clarke, 1894, pl. 37, figs. 5, 11; Hall and Clarke, 1895, pl. 51, figs. 27-33.
Eumetria costata Weller, 1914, p. 445, pl. 76, figs. 25-29; Gordon and Henry, 1981, pl. 4, fig. 12; Henry and Gordon, 1992, pl. 2, fig. 21.

Elongate oval, biconvex shell; hinge short; dorsal interarea small, triangular, curved; greatest width anterior to midlength, greatest convexity posterior to midlength; lateral margins flatly convex posteriorly, becoming more strongly convex anteriorly; ventral margin convex, shallowly uniplicate; shell material thin; punctate.

Pedicle valve with beak slightly overhanging hingeline, uniformly convex longitudinally, slightly and broadly sulcate anteriorly; beak penetrated by large, permesothyridid, labiate foramen; conjunct deltidial plates; ornamentation of uniform adjoining plicae, becoming wider anteriorly; interspaces lacking; plicae flatly convex laterally, forming a ridge medially; internally (fig. 5), denticles large, flattened; dental plates lacking.

Brachial valve with narrow interarea; slight, flat fold anteriorly; ornamentation as on pedicle valve; internally (fig. 5), cardinal plate with supporting plate connected to crural plates; jugum joined medially by thin curved saddle; spiralium directed laterally and containing at least eight whorls.

Measurements.—A distorted specimen is 18.0 mm long and 15.1 mm wide; thickness indeterminate.

Material studied.—Two specimens, one from locality 6 (OSU 51085), the other (OSU 22904), poorly preserved, from an unknown locality.

Discussion.—Weller (1914, p. 443) discussed the problems related to the use of Shumard's 1854 name *Eumetria marcyi* because of the loss of the type specimen. He also noted the large variation in shape and number of plications of *E. verneuiliana*, *E. costata*, and *E. vera*, all described by Hall (1858b) from the Mississippian of Iowa.

Both specimens from the Maxville Limestone have plications in size and number similar to that described for *E. costata*. Gordon and Henry (1981, pl. 4, fig. 12) and Henry and Gordon (1992, pl. 2, fig. 21) illustrated a specimen of *E. costata* from the Bramwell Member of the Bluestone Formation in Virginia. A collection of 25 specimens of *Eumetria* from the Lillydale Shale in West Virginia, made by James Busanus, contains specimens of various size and number of plications ranging through those of *E. verneuiliana* and *E. costata*. Busanus (1974) recognized the specimens as *E. verneuiliana*, which I believe is correct, with the collection showing much of the variations possible in the species. Because *E. verneuiliana* predates *E. costata* and *E. vera*, the latter species are placed in synonymy with *E. verneuiliana*.

Eumetria iowaensis Carter, 1972, has fewer costae on a valve—36—whereas *E. verneuiliana* has 40 or more. Otherwise the two species are very similar.

Repository.—OSU 22904, 51085.

Genus *Cleiothyridina* Buckman, 1906
Cleiothyridina sublamellosa (Hall, 1858)
Pl. 3, figs. 24-29

Athyris sublamellosa Hall, 1858b, p. 702, pl. 27, figs. 1a-c; Keyes, 1894, p. 92.
Athyris obvis McChesney, 1861, p. 81.
Spirigera clintonensis Swallow, 1863, p. 89.
Spirigera americana Swallow, 1863, p. 89.
Cliothyris royssi Hall and Clarke, 1894, pl. 35, fig. 10; Hall and Clarke, 1895, pl. 46, fig. 24.
Cleiothyris hirsuta Morse, 1911, p. 388, fig. 15.
Cleiothyridina sublamellosa Weller, 1914, p. 482, pl. 80, figs. 31-60.

Small, biconvex, subcircular shell; valves of approximately equal convexity; pedicle valve with greatest convexity near midlength, brachial valve with greatest convexity posterior to midlength; lateral and anterior margins uniformly curved; anterior margins rectimarginate; impunctate.

Pedicle valve with beak reclining on brachial beak; medial flattening of valve may be present; foramen small,

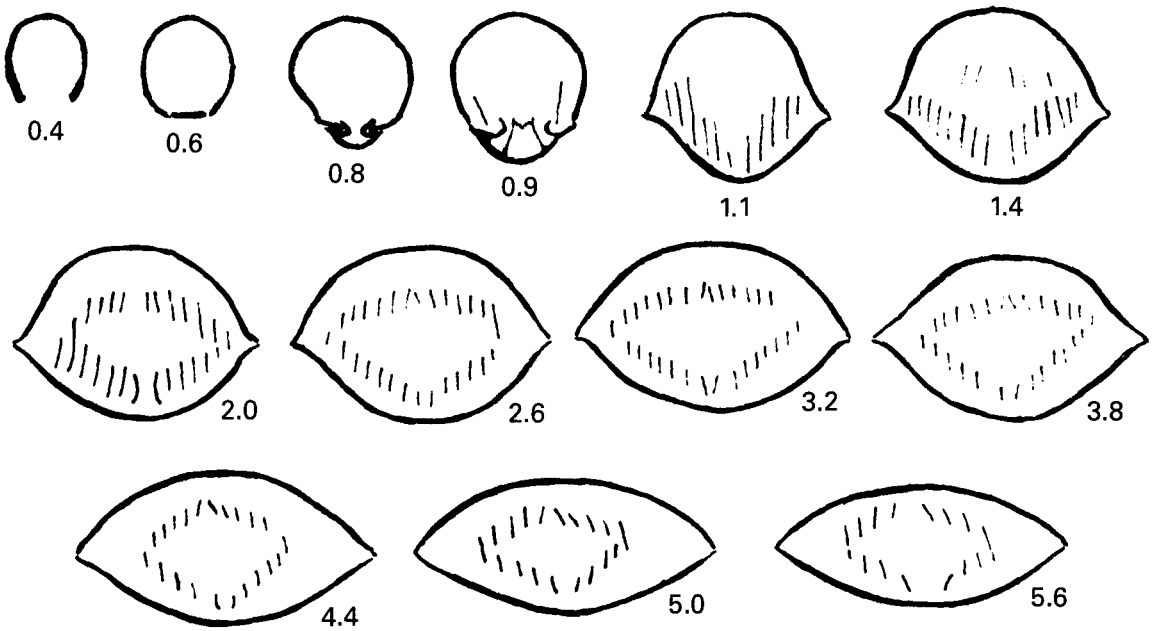

FIGURE 5.—Transverse serial sections of *Eumetria verneuiliana* (Hall) from the Reynolds Limestone, Green Limestone Co. quarry, Greer, West Virginia, approximately X3.6. Numbers refer to distance in millimeters from ventral beak.

circular; surface ornament of nearly equally spaced, anteriorly projected, flattened spines that attain a length of at least 0.8 mm; internally (fig. 6), dental plates long, diverging; teeth relatively large.

Brachial valve ornamented as pedicle valve; internally (fig. 6), hinge plate long, subquadrate, with a slight medial inflection; sockets strongly developed; jugum and other features not observed.

Measurements.—See table 4.

Material studied.—Four specimens from locality 6 and three from an unknown locality.

Discussion.—*Cleiothyridina sublamellosa* differs from *C. hirsuta* (Hall, 1857) by having a subcircular shape rather than being narrower and more attenuate posteriorly. *Cleiothyridina parvirostra* (Meek & Worthen, 1860) is a larger species with a subpentagonal shape as in *C. lenticularis* Weller, 1914.

Repository.—OSU 22896, 51086-51088.

Genus *Composita* Brown, 1849
Composita subquadrata (Hall, 1858)
Pl. 4, figs. 1-21; fig. 7

Athyris subquadrata Hall, 1858b, p. 703, pl. 27, figs. 2a-d; p. 708, fig. 118; Whitfield, 1893, p. 472, pl. 10, figs. 1-3.
Seminola subquadrata Morse, 1911, p. 384, figs. 13a-c.
Composita subquadrata Weller, 1914, p. 489, pl. 81, figs. 1-15; Gordon and Henry, 1981, pl. 3, figs. 18-20; Henry and Gordon, 1992, pl. 1, fig. 30, pl. 2, fig. 19, pl. 4, fig. 23.

Medium-sized biconvex shell, subpentagonal in outline; greatest width anterior to midlength, greatest thickness posterior to midlength; lateral margins flaring widely, gently convex, curving sharply into concavity formed by sulci bounding fold on brachial valve; anterior margin strongly paraplicate; surface smooth except for comarginal growth lines that become coarser anteriorly and laterally; impunctate.

Pedicle valve with strongly arched umbonal area; sulcus beginning anterior to umbo becoming progressively

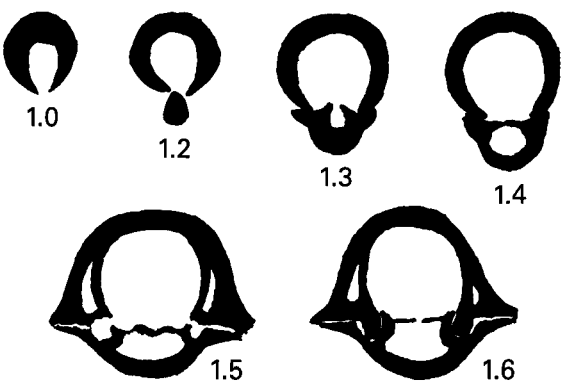

FIGURE 6.—Transverse serial sections of *Cleiothyridina sublamellosa* (Hall), approximately X6.6, locality 6. Numbers refer to distance in millimeters from ventral beak.

TABLE 4.—*Measurement (in mm) of* Cleiothyridina sublamellosa *(Hall)*

OSU specimen no.	Length	Width	Thickness
51086	8.9	8.0	5.2
51087	8.8	8.6	5.5
51088	10.8[1]	10.9[1]	

[1]Estimated.

wider and deeper to anterior margin bordered by low, rounded folds corresponding to sulci on brachial valve; foramen large, terminal; internally (fig. 7), well-developed, long, dental plates; teeth large; two low ridges parallel and close to median line as muscle-bounding ridges.

Brachial valve with strong fold beginning anterior to umbo bordered by pronounced sulci; fold commonly bears a medial groove; tightly incurved beak occludes delthyrium; internally (fig. 7), cardinal plate large, perforated, posterior flanges small; jugum with V-shaped saddle, narrow stem, and arms that extend posteriorly ending between first and second volutions of spiralium; spiralia with nine volutions; low median septum (myophragm) present anteriorly.

Measurements.—See table 5.

Material studied.—Several hundred specimens from localities 1, 3-7, 9, 12, 14.

Discussion.—*Composita subquadrata* is similar to *C. trinuclea* (Hall, 1858) but does not develop a narrow sulcus on the brachial fold which makes the anterior margin bisulcate. Immature specimens, especially those in which the fold and sulcus are not strongly developed, might easily be mistaken for other taxa such as *C. globosa* Weller, 1914, or *C. lewisensis* Weller, 1914.

Repository.—OSU 51089-51099, 51125-51128.

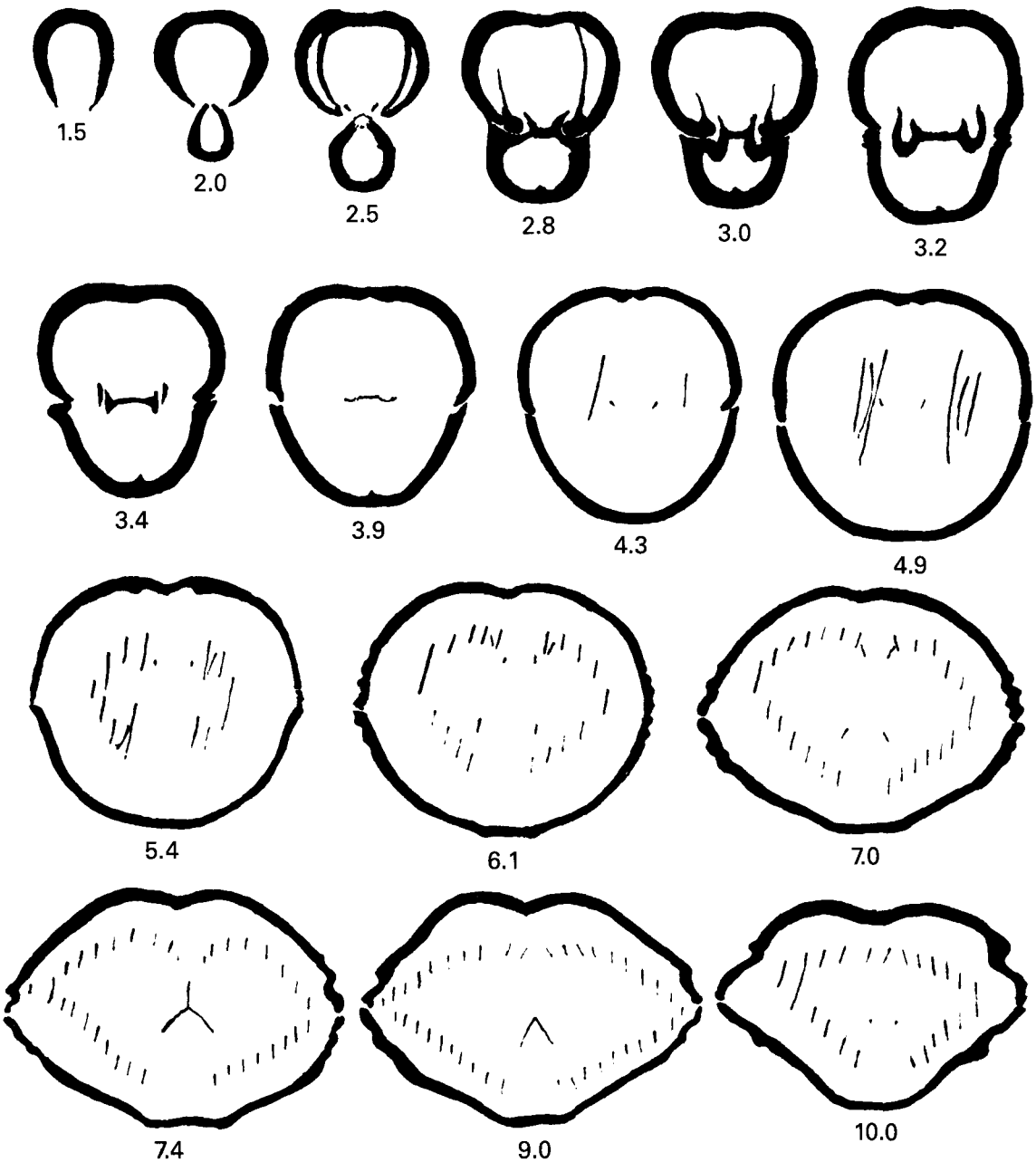

FIGURE 7.—Transverse serial sections of *Composita subquadrata* (Hall), approximately X4.0, locality 6. Numbers refer to distance in millimeters from ventral beak.

TABLE 5.—*Measurements (in mm) of* Composita subquadrata *(Hall)*

OSU specimen no.	Length	Width	Thickness
51089	19.2	19.8	11.8
51090	13.8	15.2	8.5
51091	12.5	12.8	8.9
51092	15.7	15.6	11.1
51093	12.5	11.8	7.8
51094	17.7	18.1	11.3
51095	18.0	18.7	11.1
51096	15.0	14.8	8.7
51097	12.0	13.1	7.5
51098	10.1	10.6	5.8
51099	9.4	9.0	5.5

Genus *Anthracospirifer* Lane, 1963
Anthracospirifer leidyi (Norwood & Pratten, 1855)
Pl. 4, figs. 22-38; pl. 5, figs. 1-12; fig. 8

Spirifer leidyi Norwood and Pratten, 1855, p. 72, pl. 9, figs. 2a-c; Hall, 1883, pl. 55, figs. 25, 26; Hall and Clarke, 1894, pl. 27, figs. 16, 17; Hall and Clarke, 1895, pl. 30, figs. 25, 26; Weller, 1914, p. 345, pl. 47, figs. 17-31.
Spirifera rockymontana? Whitfield, 1891, p. 584, pl. 13, fig. 20; Whitfield, 1893, p. 471, pl. 9, fig. 20.
Spirifera leidyi Keyes, 1894, p. 82.
Spirifer keokuk Morse, 1911, p. 377, fig. 11.
Anthracospirifer leidyi Gordon and Henry, 1981, pl. 4, fig. 13; Henry and Gordon, 1992, pl. 2, figs. 29, 30, pl. 4, figs. 24-27.

Small to medium-sized spiriferid; hingeline ranging from mucronate forming maximum width to shortened with maximum width near midlength of shell; maximum thickness near midlength of mucronate form, posterior to midlength in short-hinged form; shell material thin, plicate, anterior margin parasulcate; impunctate.

Pedicle valve with beak overhanging brachial umbo; wide, apsacline interarea, vertically grooved; delthyrium triangular, hypothyroid, deltidial plates narrow; sulcus beginning at beak widening anteriorly, more pronounced in mucronate shells, sulcus with three plications, lateral surfaces with up to 14 plications on mucronate forms; plication bordering sulcus more prominent than others; surface ornamented with fine network of lirae; internally (fig. 8), short, converging dental plate; teeth small; two low ridges parallel median line as muscle-bounding ridges.

Brachial valve with strongly incurved beak and umbo; interarea narrow, apsacline; fold starting at beak becoming wider and more pronounced anteriorly; fold with four plications, lateral surfaces with up to 14 plications; surface ornamented with fine network of lirae; internally (fig. 8), socket ridges wide, connected to crura; sockets small; spiralia of at least 12 lateral whorls; other features not observed.

Measurements.—See table 6.

Material studied.—A total of 108 complete or partial specimens from locality 6.

Discussion.—Mature specimens of *Anthracospirifer leidyi* from the Maxville Limestone show a large variation in shape from strongly mucronate to subpentagonal. Immature individuals 12-16 mm wide also show differences in alateness. However, the shape and distribution of the plications is consistent irrespective of size or shape of the shell. The fine network of lirae commonly is lost in preservation.

All specimens sectioned and the two pedicle-valve interiors illustrated (pl. 5, figs. 9, 10) have a heavy secondary calcareous deposit in the beak-umbo area which obscures internal structures.

Whitfield (1891, 1893) described and illustrated *Spirifera rockymontana*? Marcou, 1858. Morse (1911), in his study of the Maxville fauna, used Whitfield's illustration and quoted his 1893 description. However, Morse assigned this taxon to *Spirifer keokuk* Hall, 1858, although he thought some specimens closely resembled *S. rockymontana*. The latter species, found in the Lower Pennsylvanian, has bifurcating plications on the fold and sulcus. Weller (1914, p. 340) included both Whitfield's and Morse's designations in synonymy with *S. pellaensis* Weller, 1914, and noted in the remarks concerning *S. leidyi* that it did not have as great a variation in shape as *S. pellaensis*. Specimens from the Maxville Limestone have a greater variation in shape than *A. pellaensis* in which the subpentagonal form develops a more highly and strongly arched pedicle valve posteriorly (pl. 4, figs. 29, 30) and also differs in having narrower plications than in both *A. pellaensis* and *A. keokuk*.

Repository.—OSU 51100-51113.

Genus *Torynifer* Hall & Clarke, 1894
Torynifer setigera (Hall, 1858)
Pl. 5, figs. 13-16

Spirifer setigerus Hall, 1858b, p. 705, pl. 27, figs. 4a, b; Hall and Whitfield, 1877, p. 270, pl. 5, figs. 17, 18; Hall, 1883, pl. 61, figs. 26, 27; Hall and Clarke, 1894, pl. 36, figs. 26, 27; Keyes, 1894, p. 83.
Reticularia setigerus Beede, 1906, p. 1318, pl. 21, figs. 1, 1a.
Reticularia pseudolineata? Beede, 1906, p. 1317, pl. 21, fig. 5.
Reticularia setigera Girty, 1911, p. 69, pl. 8, fig. 6; Weller, 1914, p. 431, pl. 74, figs. 12-22.
Torynifer setigera Henry and Gordon, 1992, pl. 2, fig. 22.

Medium-sized biconvex shell, valves of subequal convexity, cardinal margins rounded, lateral margins more strongly convex than parasulcate anterior margin; greatest width anterior to midlength, greatest thickness posterior to midlength; hingeline short; impunctate.

Pedicle valve with strongly arched umbo, beak overhanging interarea; sulcus faint posteriorly, becoming wider and deeper anteriorly; interarea short, curved; delthyrium hypothyroid; shape of deltidial plates and pedicle opening not seen; surface with low, comarginal growth lamellae with fine radial lines between lamellae probably reflecting presence of spinose extensions of lamellae; internal features not seen.

Brachial valve slightly wider than long; beak not seen; strongly convex just anterior to umbo; very faint groove starting posterior to midlength increasing only slightly in size to anterior margin in midline of low fold; ornamentation as on pedicle valve; internal features not seen.

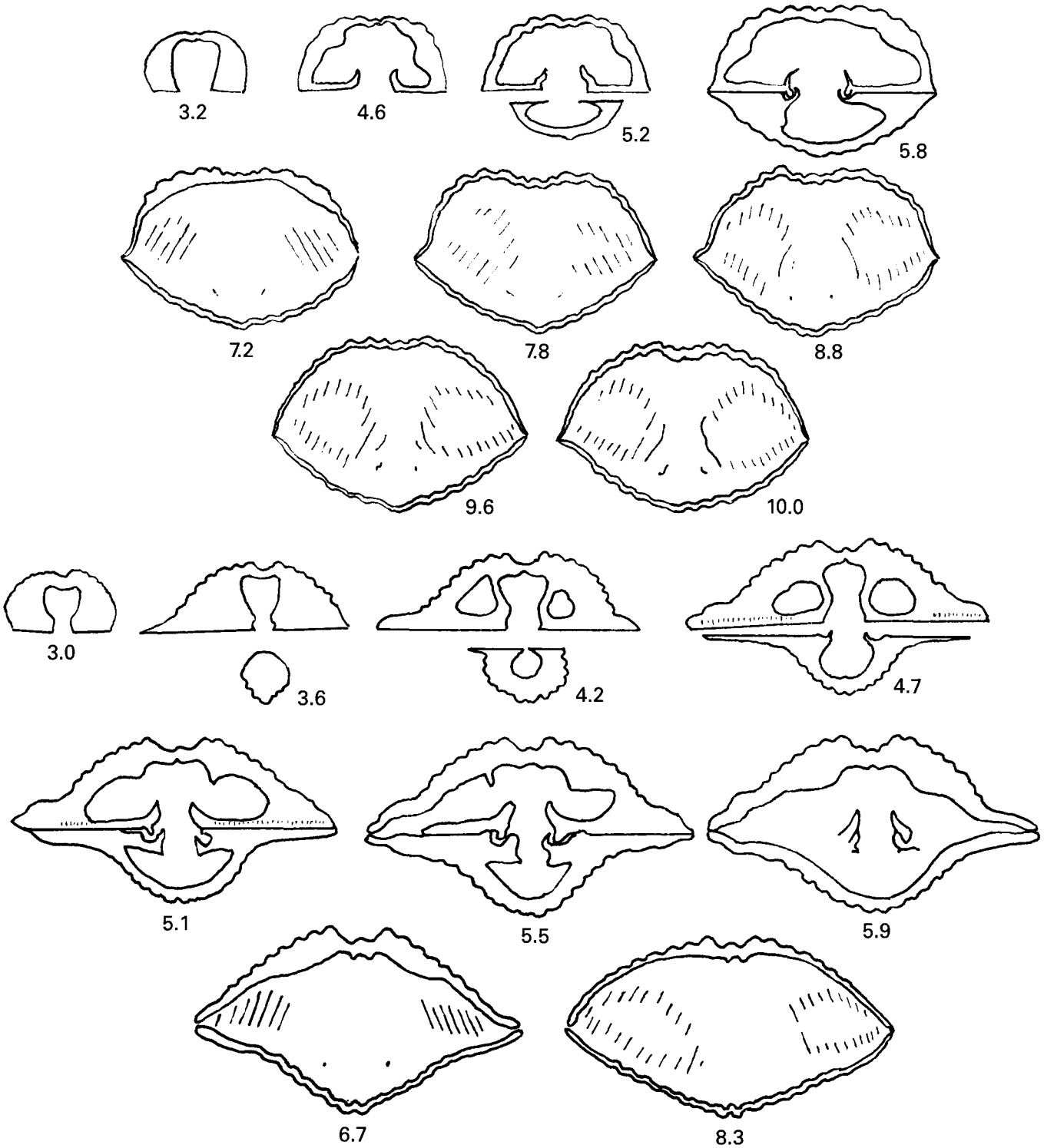

FIGURE 8.—Transverse serial sections of *Anthracospirifer leidyi* (Norwood & Pratten), approximately X2.2, locality 6. Upper series is of short-hinge specimen and lower series is of long-hinge specimen. Numbers refer to distance in millimeters from ventral beak.

TABLE 6.—*Measurements (in mm) of* Anthracospirifer leidyi *(Norwood & Pratten)*

OSU specimen no.	Length	Width	Thickness
51100	22.4	25.7	22.6
51101	20.6	34.5[1]	15.9
51102	22.4	19.7	16.7
51103	15.9	29.5[1]	13.6
51104	17.6	22.9	13.6
51105	14.0	23.9	10.2
51106	17.4	18.6	12.3
51107	10.7	12.4	7.8
51108	13.1	14.4	8.8
51109	14.4	12.5	11.0
51110	13.0	17.0	9.5

[1]Estimated.

Measurements.—Specimen is 10.8 mm long, 13.9 mm wide, 8.3 mm thick.

Material studied.—One specimen from locality 15.

Discussion.—The specimen described above is slightly distorted; the pedicle beak is compressed, obscuring most of the interarea. The shell is exfoliated so the spinose ornamentation is not well preserved. This specimen is smaller than those illustrated by Weller (1914, pl. 74, figs. 12-22), and the fold and sulcus have not become as prominent as on those pictured. Otherwise it agrees closely with Weller's description. *Torynifer pseudolineata* (Hall, 1858) and *T. salemensis* (Weller, 1914) are both larger species from lower in the Mississippian, and *T. cooperensis* (Swallow, 1860) from Missouri is commonly wider with a more strongly convex brachial valve at the same growth stage than *T. setigera.*

Repository.—OSU 24506.

Genus *Martinia* M'Coy, 1844
Martinia contracta (Meek & Worthen, 1862)
Pl. 3, figs. 30-32

Spirifera glabra var. *contracta* Meek and Worthen, 1862, p. 143; Meek and Worthen, 1866, p. 298, pl. 23, figs. 5a, b.
Spirifer glabra Herrick, 1888, pl. 11, fig. 15.
Spirifer (Martinia) contractus Whitfield, 1891, p. 583, pl. 13, figs. 17-19.
Spirifera contracta Keyes, 1894, p. 83.
Spirifera (Martinia) contracta Whitfield, 1893, p. 471, pl. 9, figs. 17-19.
Martinia sulcata Weller, 1914, p. 422, pl. 75, figs. 11-14.
Martinia contracta Bassler, 1909, pl. 29, fig. 11; Morse, 1911, p. 375, figs. 10a-c; Weller, 1914, p. 420, pl. 75, figs. 1-10; Gordon and Henry, 1981, pl. 1, figs. 13, 14; Henry and Gordon, 1992, pl. 1, figs. 28, 29.

Medium-sized, biconvex shell; pedicle valve more strongly convex than brachial valve; greatest width near midlength, greatest thickness posterior to midlength; cardinal margins rounded, lateral margins convex, anterior margin parasulcate; hingeline short; ornament of comarginal growth lines and faint, narrow radiating ridges; impunctate.

Pedicle valve with strongly incurved beak overhanging hingeline; faint sulcus beginning just anterior to umbo becoming wider and slightly deeper anteriorly; interarea short, curved; delthyrium hypothyroid, deltidial plates large, subtriangular; pedicle opening subcircular; internal features not observed.

Brachial valve with small beak; umbo moderately convex; interarea small, apsacline; internal features not observed.

Measurements.—Specimen is 15.0 mm wide, 8.3 mm thick, and is estimated to be approximately 14.0 mm long.

Material studied.—One specimen, slightly broken anteriorly and laterally, from an unknown locality.

Discussion.—The single specimen available for study, although somewhat broken and the outer shell layer partially exfoliated, shows the distinctive features of *Martinia.* Whitfield (1891, 1893) described *Spirifera (Martinia) contracta* from the Maxville Limestone and Morse (1911), using Whitfield's illustrations, redescribed the species. Both authors also show a brachial view of the type specimen from Illinois. Weller (1914, p. 420) placed both Whitfield's and Morse's citations in synonymy with *M. contracta* and noted that a considerable variation in shape and development of the sulcus was present in the species. Weller also described a new species, *M. sulcata,* from the Chesterian of Kentucky, stating it differed from *M. contracta* in being shorter and broader, having a stronger sulcus anteriorly, and less conspicuous radial markings. It appears that the characteristics of *M. sulcata* fall within the variation of form and ornamentation of *M. contracta* and is placed in synonymy here.

Repository.—OSU 22901.

Genus *Girtyella* Weller, 1914
Girtyella indianaensis (Girty, 1908)
Pl. 5, figs. 17-33; figs, 9, 10

Terebratula turgida Whitfield, 1891, p. 586, pl. 13, figs. 21, 22; Whitfield, 1893, p. 473, pl. 9, figs. 21, 22.
Harttina indianaensis Girty, 1908, p. 293, pl. 19, figs. 6-15.
Dielasma turgida Morse, 1911, p. 381, figs. 12a, b.
Girtyella indianaensis Weller, 1911, p. 442, figs. 2a-i; Weller, 1914, p. 275, pl. 34, figs. 1-24, fig. 33.

Small to medium-sized, oval, biconvex shell; greatest width near midlength, greatest thickness posterior to midlength; anterior margin faintly parasulcate; unornamented except for comarginal growth lines; shell material thin, finely punctate.

Pedicle valve with strongly arched umbonal area, beak overhanging umbo of brachial valve; shallow sulcus beginning near midlength; foramen large, elongate, bordered internally by adminicula; internally (figs. 9, 10), dental plates long, thin; teeth small.

Brachial valve more convex posteriorly; lacking a distinct fold; internally (figs. 9, 10), median septum supporting imperforate cardinal plates; deltidiform loop with transverse band sharply arched posteriorly and ventrally.

Measurements.—See table 7.

Material studied.—One to more than a dozen specimens per locality from localities 1, 2, 6, 7, 9, 12.

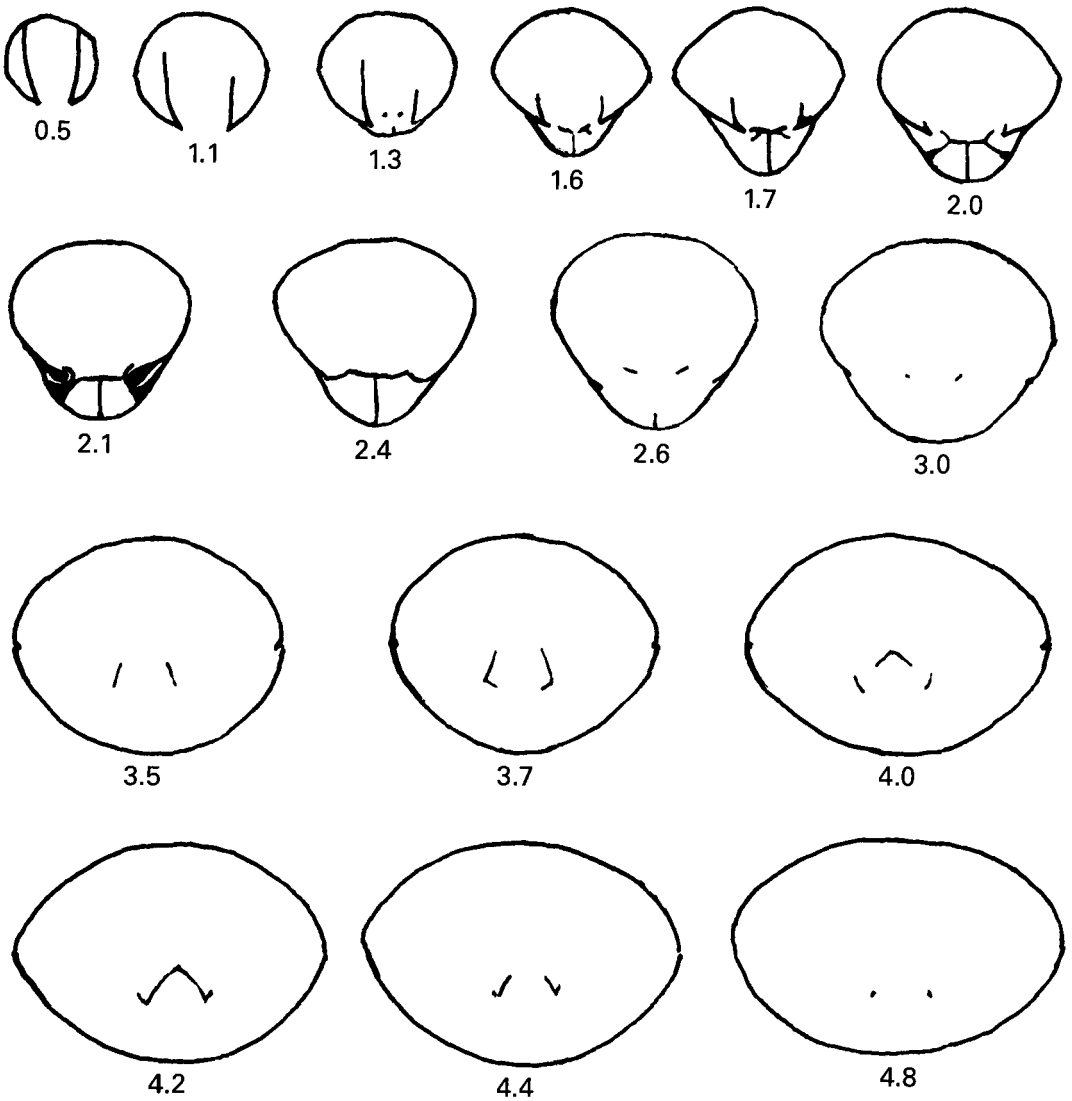

FIGURE 9.—Transverse serial sections of a mature *Girtyella indianaensis* (Girty), approximately X4.7, locality 1. Numbers refer to distance in millimeters from ventral beak.

TABLE 7.—*Measurements (in mm) of* Girtyella indianaensis *(Girty)*

OSU specimen no.	Length	Width	Thickness
51114	15.3	12.6	8.4
51115	13.7	11.9	7.8
51116	13.0	9.3	9.2
51117	11.2	10.0	6.8
51118	11.0	9.4	6.3
51119	11.6	10.0	8.3
51120	7.9	6.9	4.3
51121	7.0	7.3	4.0
51122	15.0	12.3	9.7
51123	13.6	11.9	9.3

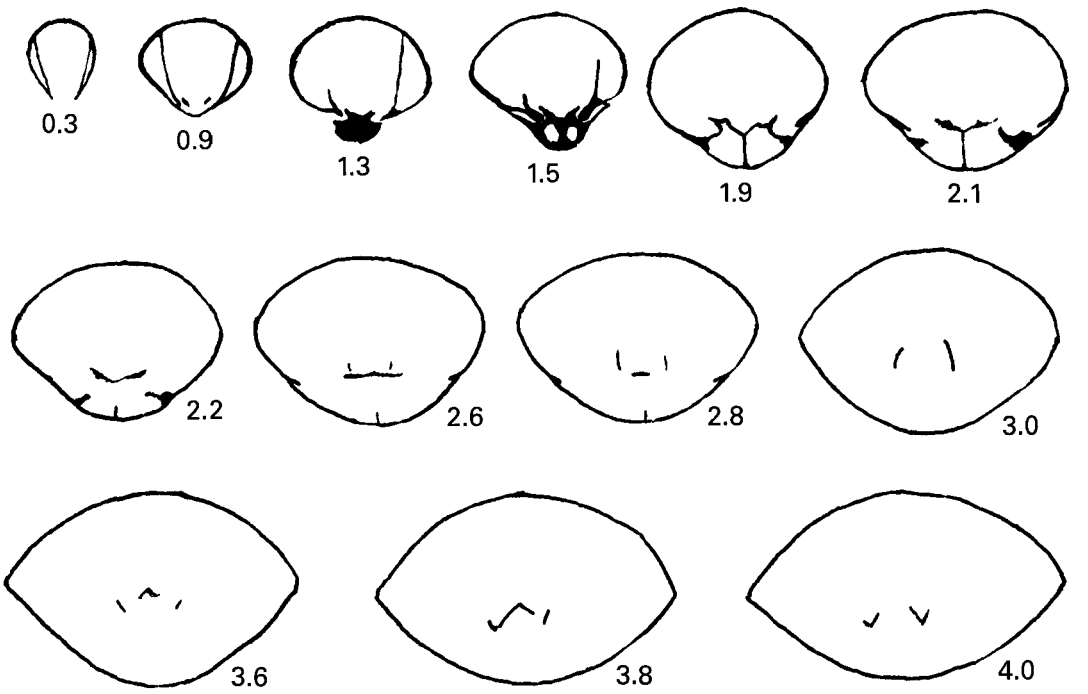

FIGURE 10.—Transverse serial sections of a juvenile *Girtyella indianaensis* (Girty), approximately X4.7, locality 1. Numbers refer to distance in millimeters from ventral beak.

Discussion.—Whitfield (1893) and Morse (1911) compared specimens of *G. indianaensis* from the Maxville Limestone with specimens from the Salem Limestone of Indiana and could not see any significant difference outwardly between them, with which I agree. Internal structures of *G. indianaensis* from the Maxville Limestone were not seen or discussed previously. Weller (1914, fig. 33) illustrated structures of the rostral portion of the brachial valve from the Renault Formation in Illinois. The presence of the median septum supporting the cardinal plate differentiates *Girtyella* from *Dielasma* King, 1859, with which it is often confused. *Girtyella turgida* (Hall, 1858) differs from *G. indianaensis* by the presence of a sulcate brachial valve. *Girtyella intermedia* Weller, 1914, differs in having a narrow fold within the sulcus on the brachial valve; a narrow fold also is present on *G. brevilobata* (Swallow, 1863).

Repository.—OSU 51114-51123.

REFERENCES CITED

Andrews, E. B., 1870, Report of progress in the Second District: Ohio Division of Geological Survey Report of Progress in 1869, p. 53-135.

Babcock, L. E., 1996, Phylum Arthropoda, Class Trilobita, *in* Feldmann, R. M., and Hackathorn, Merrianne, Fossils of Ohio: Ohio Division of Geological Survey Bulletin 70, p. 90-113.

Bassler, R. S., 1909, The cement resources of Virginia west of the Blue Ridge: Virginia Geological Survey Bulletin 2A, 309 p.

Beede, J. W., 1906, Fauna of the Salem Limestone of Indiana—Brachiopoda: Indiana Geological Survey Annual Report 30 for 1905, p. 1297-1321.

Brezinski, D. K., 1988, Appalachian Carboniferous trilobites: Journal of Paleontology, v. 62, p. 934-945.

Brown, Thomas, 1849, Illustrations of the fossil conchology of Great Britain and Ireland, with descriptions and localities of all species: 273 p.

Bruguière, J. G., 1797, Tableau encyclopédique et méthodique des trois règnes de la nature: v. 2, Vers, Coquilles, Mollusques et Polypiers: Agasse, Paris, pls. 93-314.

Buckman, S. S., 1906, Brachiopod nomenclature: Annals and Magazine of Natural History, v. 18, p. 321-327.

Busanus, J. W., 1974, Paleontology and paleoecology of the Mauch Chunk Group in northwestern West Virginia: Bowling Green State University, M.S. thesis (unpub.), 388 p.

Carter, J. L., 1972, Early Mississippian brachiopods from the Gilmore City Limestone of Iowa: Journal of Paleontology, v. 46, p. 473-491.

Daudin, F. M., 1800, Recueil de memoirs et notes sur des espèces inédites ou peu connues de mollusques, de vers et de zoophytes: Fuchs, Paris, 48 p.

Fischer de Waldheim, Gotthelf, 1829, Quelques fossiles du gouvernement de Moscou: Société Impériale des Naturalistes de Moscou Bulletin, v. 1, no. 12, p. 375-376.

Girty, G. H., 1899, Devonian and Carboniferous fossils (of Yellowstone National Park): U.S. Geological Survey Monograph 32, pt. 2, p. 479-599.

_____ 1903, The Carboniferous formations and faunas of Colorado: U.S. Geological Survey Professional Paper 16, 546 p.

_____ 1904, Note on the Carboniferous fossils (of the Bisbee quadrangle, Arizona): U.S. Geological Survey Professional Paper 21, p. 46-54.

_____ 1908, On some new and old species of Carboniferous fossils: U.S. National Museum Proceedings 34, p. 281-303.

_____ 1909, The fauna of the Caney Shale of Oklahoma: U.S. Geological Survey Bulletin 377, 106 p.

_____ 1910, New genera and species of Carboniferous fossils from the Fayetteville Shale of Arkansas: New York Academy of Science Annals, v. 20, p. 189-238.

_____ 1911, The fauna of the Moorefield Shale of Arkansas: U.S. Geological Survey Bulletin 439, 148 p.

Gordon, Mackenzie, Jr., and Henry, T. W., 1981, Late Mississippian and Early Pennsylvanian invertebrate faunas, east-central Appalachians—a preliminary report, *in* Roberts, T. G., ed., GSA Cincinnati '81 Field Trip Guidebooks, v. 1, Stratigraphy, sedimentology: American Geological Institute, p. 165-171.

Hall, James, 1857, Descriptions of new species of Palaeozoic fossils, from the Lower Helderberg, Oriskany Sandstone, Upper Helderberg, Hamilton and Chemung Groups: Albany, New York State Cabinet of Natural History 10th Annual Report, Part C, Appendix, p. 41-186.

_____ 1858a, Descriptions of new species of fossils from the Carboniferous rocks of Indiana and Illinois: Transactions of the Albany Institute, v. 4, 36 p.

_____ 1858b, Report on the Geological Survey of the state of Iowa, embracing the results of investigations made during portions of the years 1855-1857: Palaeontology, v. 1, pt. 2, p. 473-724, published by authority of the legislature of Iowa, Des Moines.

_____ 1864, Description of new species of fossils from the Carboniferous limestones of Indiana and Illinois: Indiana Department of Geology and Natural History 12th Annual Report, p. 239-400.

_____ 1883, Paleontology: Spergen Hill fossils: Indiana Geological Survey 12th Annual Report for 1882, p. 319-375.

Hall, James, and Clarke, J. M., 1892, An introduction to the study of the genera of Palaeozoic Brachiopoda: New York State Geologist Annual Report 11, p. 133-223.

_____ 1894, An introduction to the study of the genera of Palaeozoic Brachiopoda: New York State Geological Survey, Palaeontology, v. 8, pt. 1, 367 p.

_____ 1895, An introduction to the study of the genera of Palaeozoic Brachiopoda: New York State Geologist Annual Report 13, p. 749-1015.

Hall, James, and Whitfield, R. P., 1877, Paleontology: U.S. Geological Exploration of the 40th Parallel, v. 4, p. 193-302.

Henry, T. W., and Gordon, Mackenzie, Jr., 1992, Middle and Upper Chesterian brachiopod biostratigraphy, eastern Appalachian Virginia and West Virginia, *in* Sutherland, P. K., and Manger, W. L., eds., Recent Advances in Middle Carboniferous Biostratigraphy—A Symposium: Oklahoma Geological Survey Circular 94, p. 1-21.

Herrick, C. L., 1888, Geology of Licking County, Pt. IV: Denison University Science Laboratories Bulletin, v. 4, pt. 1, p. 11-60, 97-123.

Hoare, R. D., 1991, Ontogeny and variation in *Glyptopleura costata* (McCoy) (Ostracoda: Mississippian, Chesterian): Journal of Paleontology, v. 65, 760-766.

_____ 1993, Ostracodes from the Maxville Limestone (Mississippian, Chesterian) from Ohio: Journal of Paleontology, v. 67, p. 571-585.

Hoare, R. D., Hansen, M. C., Merrill, G. K., and Hook, R. W., 1988, Preserved color patterns of Pectinacea (Bivalvia, Mississippian) from Ohio: Journal of Paleontology, v. 62, p. 653-654.

Hoare, R. D., and Skipp, Betty, 1995, Calcareous microfossils from the Upper Mississippian (Chesterian) Maxville Limestone, southeastern Ohio: Journal of Paleontology, v. 69, p. 617-624.

Horowitz, A. S., 1969, Some Chester correlations in the Appalachian region (abs.), *in* Abstracts for 1968: Geological Society of America Special Paper 121, p. 662.

Keyes, C. R., 1894, Paleontology of Missouri, part 2: Missouri Geological Survey, v. 5, 266 p.

King, William, 1859, On *Gwynia*, *Dielasma*, and *Macandrevia*, three new genera: Dublin University, Zoology and Botany Association Proceedings, v. 1, pt. 3, p. 256-262.

Lane, N. G., 1963, A silicified Morrowan brachiopod faunule from the Bird Spring Formation, southern Nevada: Journal of Paleontology, v. 37, p. 379-392.

Marcou, Jules, 1858, Geology of North America; with two reports on the prairies of Arkansas and Texas, the Rocky Mountains of New Mexico, and the Sierra Nevada of California: Zurich, 144 p.

M'Coy, Frederick, 1844, A synopsis of the characters of the Carboniferous limestone fossils of Ireland: Dublin, 207 p.

McChesney, J. H., 1859 (1860), Descriptions of new species of fossils from the Palaeozoic rocks of the Western States: Transactions of the Chicago Academy of Sciences, v. 1, p. 1-76.

_____ 1861, Descriptions of new species of fossils from the Palaeozoic rocks of the Western States: Transactions of the Chicago Academy of Sciences, Extract 2, p. 77-95.

Meek, F. B., and Worthen, A. H., 1860, Descriptions of new Carboniferous fossils from Illinois and other western states: Philadelphia Academy of Natural Sciences Proceedings, p. 447-472.

_____ 1862, Descriptions of new Carboniferous fossils from Illinois and Iowa: Philadelphia Academy of Natural Sciences Proceedings for 1861, p. 128-148.

_____ 1866, Descriptions of invertebrates from the Carboniferous system: Illinois State Geological Survey, v. 2, p. 143-411.

Morse, W. C., 1910, The Maxville Limestone: Ohio Division of Geological Survey Bulletin 13, 128 p.

_____ 1911, The fauna of the Maxville Limestone: Proceedings of the Ohio State Academy of Science, v. 5, Special Paper 17, p. 353-420.

Muir-Wood, Helen, and Cooper, G. A., 1960, Morphology, classification and life habits of the Productoidea (Brachiopoda): Geological Society of America Memoir 81, 447 p.

Norwood, J. G., and Pratten, Henry, 1855, Notice of fossils from the Carboniferous series of the Western States, belonging to the genera *Spirifer*, *Bellerophon*, *Pleurotomaria*, *Macrocheilus*, *Natica*, and *Loxonema*, with descriptions of eight new characteristic species: Philadelphia Academy of Natural Sciences Journal, v. 3, p. 71-77.

Owen, D. D., 1852, Description of new and imperfectly known genera and species of organic remains, *in* Report of a geological survey of Wisconsin, Iowa, and Minnesota and incidentally of a portion of Nebraska Territory: Philadelphia, 638 p.

Pander, C. H., 1830, Beiträge zur Geognosie des Russichen Reiches: St. Petersburg, Gedruckt bei K. Kray, 165 p.

Peck, J. H., Jr., and McFarland, H. B., 1954, Whitfield collection types at the University of California: Journal of Paleontology, v. 28, p. 297-309.

Scatterday, J. W., 1963, Stratigraphy and conodont faunas of the Maxville Group (Middle and Upper Mississippian) of Ohio: The Ohio State University, Ph.D. dissertation (unpub.), 162 p.

Schlotheim, E. F., von, 1820, Die Petrefactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung einer Sammlung versteinerter und fossiler Überreste der Tier-und Pflanzenreichs der Vorwelt erläutert: Becker, Gotha, v. 1, 378 p.

Shumard, B. F., 1854, Paleontology; description of the species of Carboniferous and Cretaceous fossils collected, *in* Marcy, R. B., Exploration of the Red River of Louisiana in the year 1852: U.S. 33rd Congress, 1st session, House Executive Document, p. 173-185.

Sutton, A. H., 1938, Taxonomy of Mississippian Productidae: Journal of Paleontology, v. 12, p. 537-569.

Sutton, A. H., and Wagner, O. E., Jr., 1931, New species of Chester fossils: Journal of Paleontology, v. 5, p. 23-33.

Swallow, G. C., 1860, Descriptions of new fossils from the Carboniferous and Devonian rocks of Missouri: Transactions of the St. Louis Academy of Science, v. 1, p. 635-660.

_____ 1863, Descriptions of some new fossils from the Carboniferous and Devonian rocks of Missouri: Transactions of the St. Louis Academy of Science, v. 2, p. 81-100.

Thomas, Ivor, 1914, The British Carboniferous Producti, part I, genera *Pustula* and *Overtonia*: Great Britain Geological Survey Memoir 1, pt. 4, p. 197-366.

Uttley, J. S., 1974, The stratigraphy of the Maxville group of Ohio and correlative strata in adjacent areas: The Ohio State University, Ph.D. dissertation (unpub.), 252 p.

Walcott, C. D., 1884, Paleontology of the Eureka district, Nevada: U. S. Geological Survey Monograph 8, 298 p.

Weller, Stuart, 1897, The Batesville Sandstone of Arkansas: New York Academy of Science Transactions, v. 16, p. 251-282.

_____ 1910, Internal characters of some Mississippian rhynchonelliform shells: Geological Society of America Bulletin 21, p. 497-516.

_____ 1911, Genera of Mississippian loop-bearing brachiopods: Journal of Geology, v. 19, p. 439-448.

_____ 1914, The Mississippian Brachiopoda of the Mississippi Valley Basin: Illinois State Geological Survey Monograph 1, 508 p.

White, C. A., 1860, Observations upon the geology and paleontology of Burlington, Iowa and its vicinity: Boston Journal of Natural History, v. 7, p. 209-235.

_____ 1862, Description of new species of fossils from the Devonian and Carboniferous rocks of the Mississippi Valley: Boston Society of Natural History Proceedings, v. 9, p. 8-33.

_____ 1874, Preliminary report upon invertebrate fossils collected by expeditions of 1871, 1872, and 1873, with descriptions of new species: U.S. Geographical Survey West of the 100th Meridian, p. 5-27.

_____ 1877, Report upon the invertebrate fossils collected in portions of Nevada, Utah, Colorado, New Mexico, and Arizona: U.S. Geographical Survey West of the 100th Meridian, v. 4, pt. 1, 219 p.

Whitfield, R. P., 1882, On the fauna of the Lower Carboniferous limestones of Spergen Hill, Indiana: American Museum of Natural History Bulletin, v. 1, p. 39-97.

_____ 1891, Species from the Maxville limestone, the equivalent of the St. Louis and Chester limestones of the Mississippi Valley: New York Academy of Science Annals, v. 5, p. 576-595.

_____ 1893, Species from the Maxville limestone, the equivalent of the St. Louis and Chester limestones of the Mississippi Valley: Ohio Division of Geological Survey, v. 7, p. 465-481.

Worthen, A. H., 1860, Notice of a new species of *Platycrinus* and other fossils from the Mountain Limestone of Illinois and Iowa: St. Louis Academy of Science Annals, v. 1, p. 569-571.

APPENDIX.—COLLECTING LOCALITIES

1. Former Somerset Cut Limestone quarry (abandoned) on east side of County Rd. 96, 2.1 km north of Ohio Rte. 13, Hopewell Twp., Perry Co., NW¼SW¼ sec. 32, T17N, R16W, Somerset 7.5-minute quadrangle.
2. Maxville Stone Co. quarry on west side of Ohio Rte. 668, approx. 1.1 km north of Maxville, Monday Creek Twp., Perry Co., SW¼ sec. 9, T14N, R16W, Junction City 7.5-minute quadrangle.
3. Exposure in tributary to Little Monday Creek near Ohio Rte. 668, 0.8 km north of Maxville, Monday Creek Twp., Perry Co., SE¼SW¼ sec. 9, T14N, R16W, Gore 7.5-minute quadrangle.
4. Exposure on south side of Kent Run near covered bridge, Madison Twp., Perry Co., SW¼NE¼NE¼ sec. 3, T17N, R15W, Gratiot 7.5-minute quadrangle.
5. Exposure in gully at Mt. Perry Iron Bridge (railroad bridge across Jonathan Creek), Madison Twp., Perry Co., SW¼SW¼ sec. 16, T17N, R15W, Fultonham 7.5-minute quadrangle (Gully section of Morse).
6. Abandoned quarry east of Poverty Run, Hopewell Twp., Muskingum Co., north of north line sec. 12, T1N, R9W, Gratiot 7.5-minute quadrangle.
7. Exposure in railroad cut near Wortman Iron Bridge over Jonathan Creek, Newton Twp., Muskingum Co., west line SE¼ sec. 14, T17N, R15W, Fultonham 7.5-minute quadrangle (cut #6 of Morse).
8. Exposure in railroad cut along Jonathan Creek, Madison Twp., Perry Co., sec. 15, T17N, R15W, Fultonham 7.5-minute quadrangle (cut #3 of Morse).
9. Exposure in railroad cut along Jonathan Creek, Madison Twp., Perrry Co., sec. 15, T17N, R15W, Fultonham 7.5-minute quadrangle (cut #4 of Morse).
10 Exposure in railroad cut along Jonathan Creek, Newton Twp., Muskingum Co., SE¼NW¼SW¼ sec. 14, T17N, R15W, Fultonham 7.5-minute quadrangle (cut #5 of Morse).
11. Exposure in stream 290 m downstream from covered bridge, Kent Run, Newton Twp., Muskingum Co., NW¼NW¼ sec. 2, T17N, R15W, Gratiot 7.5-minute quadrangle.
12. Former Columbia Cement Co. quarry, Newton Twp., Muskingum Co., NE¼ sec. 19, T15N, R14W, Crooksville 7.5-minute quadrangle.
13. Exposure in Kent Run, Newton Twp., Muskingum Co., NW¼NE¼ sec. 18, T15N, R14W, Crooksville 7.5-minute quadrangle.
14. Sidwell quarry, Newton Twp., Muskingum Co., SW¼ sec. 9, T15N, R14W, Zanesville West 7.5-minute quadrangle.
15. Exposure above mouth of Hough Hollow (valley tributary to Jonathan Creek), Newton Twp., Muskingum Co., sec. 24, T17N, R15W, Fultonham 7.5-minute quadrangle.
16. Exposure in Smith Chapel Run on east side of Threemile Creek approx. 0.75 km east of Smith Chapel, Green Twp., Hocking Co., T13N, R16W, Gore 7.5-minute quadrangle.
17. Former Forbe's quarry (abandoned), Hopewell Twp., Muskingum Co., SE¼SW¼ sec. 15, T1N, R9W, Gratiot 7.5-minute quadrangle.

PLATE 1

FIGURE

1. Tubes of *Spirorbis* on *Composita subquadrata* (Hall) , X7, locality 6, OSU 51126.
2. Tubes of *Cornulites* on *Composita subquadrata* (Hall), X7, locality 1, OSU 51128.
3. Trepostome bryozoan colonies on *Composita subquadrata* (Hall), X7, locality 6, OSU 51127.
4. Spat attached to brachial valve of *Diaphragmus cestriensis* (Worthen), X7, locality 1, OSU 51069.
5. *Lingula* sp. Pedicle interior, X2.3, locality 5, OSU 51051.

6-15. *Orthotetes kaskaskiensis* (McChesney), locality 6.

- 6-8. Brachial (6), pedicle (7), and dorsal (8) views, X1, OSU 51052.
- 9-11. Oblique dorsal (9), brachial (10), and right-lateral (11) views, X1, OSU 51053.
- 12, 13. Brachial (12) and pedicle (13) views, X1, OSU 51054.
- 14, 15. Pedicle and left-lateral views, X1, OSU 51055.

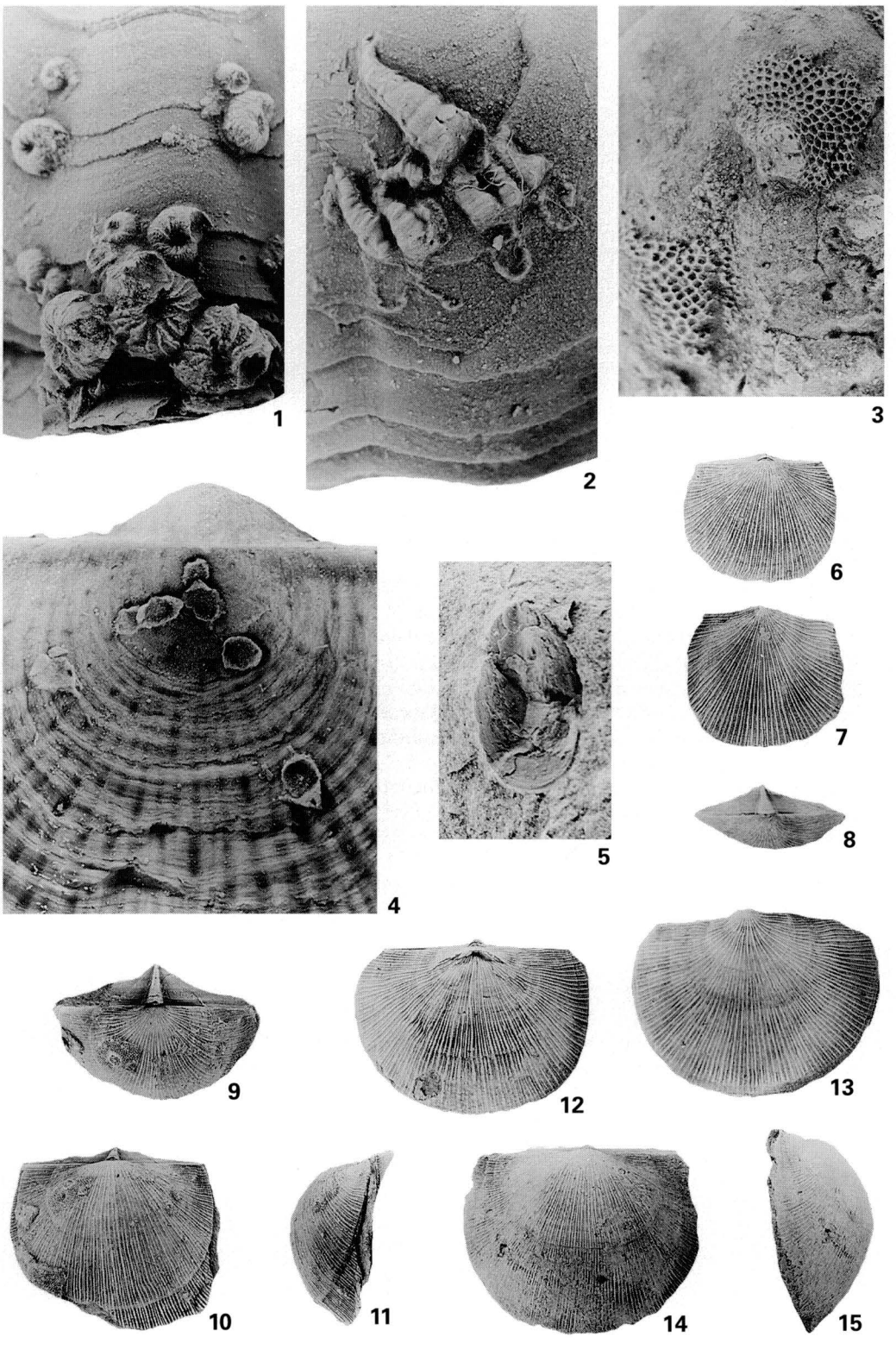
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PLATE 2

FIGURES 1-4. *Orthotetes kaskaskiensis* (McChesney), locality 6.

1-3. Brachial (1), right-lateral (2), and posterior (3) views, X1, OSU 51056.

4. Cardinal process, X7, attached in matrix to OSU 51068.

5-16. *Diaphragmus cestriensis* (Worthen).

5, 6. Pedicle (5) and left-lateral (6) views, X1.5, locality 1, OSU 51060.

7, 8. Pedicle (7) and brachial (8) views, X1.5, locality 1, OSU 15161.

9, 10. Pedicle (9) and brachial (10) views, X1.5, locality 1, OSU 51063.

11, 12. Brachial (11) and oblique brachial (12) views, X1.5, locality 1, OSU 51064.

13. Pedicle view, X1.5, locality 7, OSU 51065.

14, 15. Brachial views showing cardinal process, X7, locality 1, OSU 51057, 51058.

16. Polished section near median line showing repeated trails (white arrows), X1.5, locality 7, OSU 51067.

20, 21. *Buxtonia*? sp. Pedicle (20) and right-lateral (21) views, X1, locality 7, OSU 51074.

17-19, 22, 23. *Ovatia iowaensis*, new name.

17, 18. Pedicle (17) and brachial (18) views, X1.5, locality 6, OSU 51072.

19. Brachial view showing shell repair, X2, locality 5, OSU 51073.

22. Pedicle view, X1.5, locality 6, OSU 51068.

23. Pedicle view, X1.5, locality 6, OSU 51069.

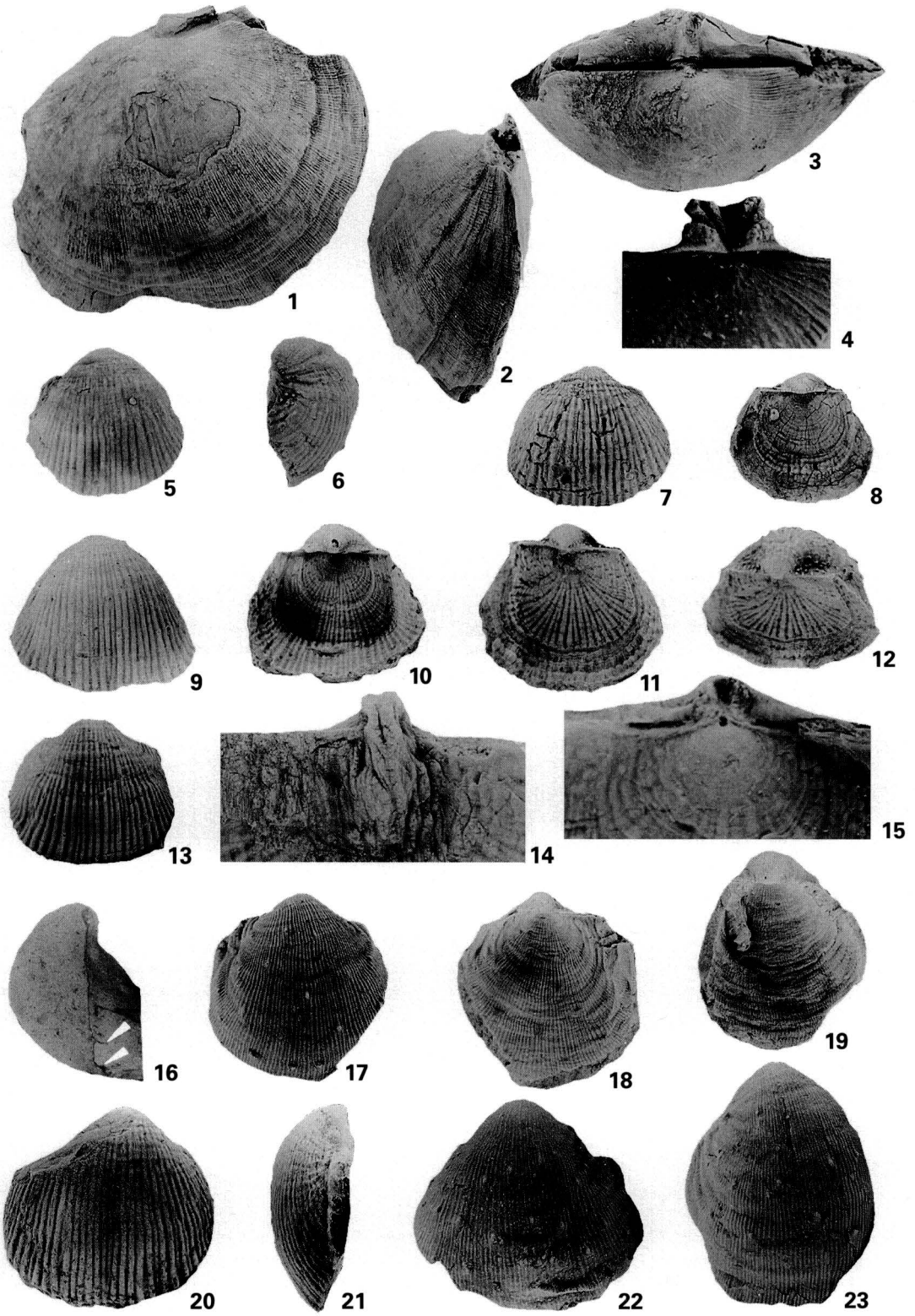
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PLATE 3

FIGURES 1-3. *Ovatia* aff. *O. elongata* Muir-Wood & Cooper.
1. Pedicle view, X1, locality 6, OSU 51070.
2, 3. Pedicle (2) and left-lateral (3) views, X5, locality unknown, OSU 51071.

4-20. *Pugnoides macgordoni* n. sp., locality 6.
4-6. Holotype, brachial (4), pedicle (5), and anterior (6) views, X2, OSU 51075.
7, 8. Anterior (7) and brachial (8) views, X2, OSU 51077. Note *Spirorbis* on *8*.
9-11. Brachial (9), pedicle (10), and right-lateral (11) views, X2, OSU 51076. Note *Spirorbis* tubes on *11*.
12-14. Brachial (12), pedicle (13), and right-lateral (14) views, X2, OSU 51074.
15-18. Brachial (15), pedicle (16), right-lateral (17), and anterior (18) views, X2, OSU 51080. Note *Spirorbis* tube on *16*.
19, 20. Brachial (19) and oblique pedicle (20) views, X2, OSU 51078. Note *Spirorbis* tubes.

21-23. *Eumetria verneuiliana* (Hall). Brachial (21), pedicle (22), and right-lateral (23) views, X2, locality 6, OSU 51085.

24-29. *Cleiothyridina sublamellosa* (Hall).
24-26. Brachial (24), anterior (25), and pedicle (26) views, X2.5, locality 6, OSU 51087.
27, 28. Brachial (27) and right-lateral (28) views, X2.5, locality 6, OSU 51086.
29. Pedicle view, X2.5, locality unknown, OSU 51088.

30-32. *Martinia contracta* (Meek & Worthen). Brachial (30), right-lateral (31), and pedicle (32) views, X2, locality unknown, OSU 29901.

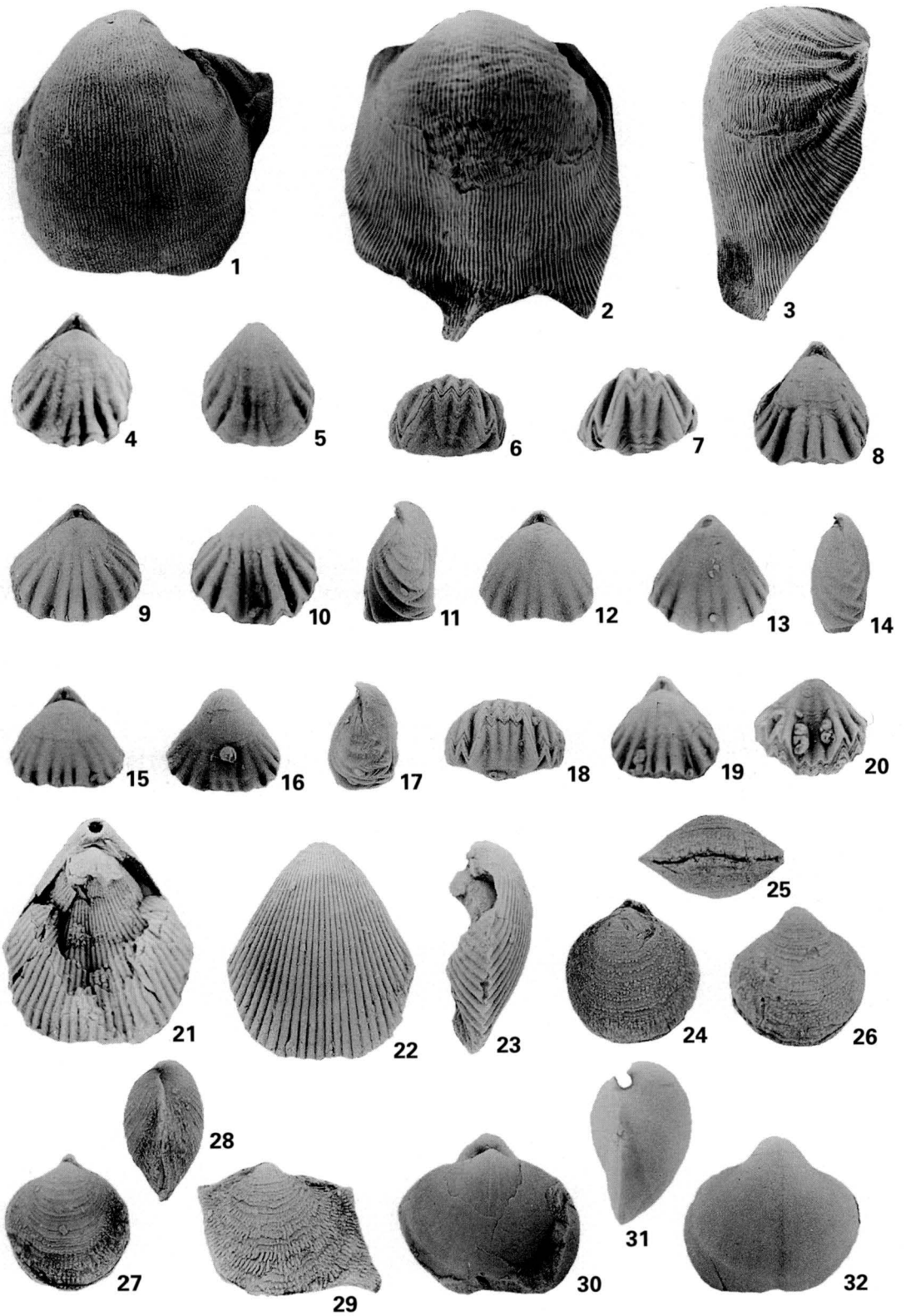
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PLATE 4

FIGURES 1-21. *Composita subquadrata* (Hall).

1, 2. Brachial (1) and anterior (2) views, X1.5, locality 1, OSU 51089.
3, 8. Brachial (3) and right-lateral (8) views, X1.5, locality 1, OSU 51095.
4, 5. Right-lateral (4) and brachial (5) views, X1.5, locality 6, OSU 51092.
6, 7. Brachial (6) and pedicle (7) views, X1.5, locality 1, OSU 51094.
9, 10. Brachial (9) and pedicle (10) views, X1.5, locality 6, OSU 51096.
11-13. Brachial (11), anterior (12), and right-lateral (13) views, X1.5, locality 1, OSU 51090.
14, 15. Brachial (14) and anterior (15) views, X1.5, locality 6, OSU 51097.
16. Brachial view, X1.5, locality 6, OSU 51093.
17, 18. Brachial (17) and pedicle (18) views, X1.5, locality 6, OSU 51098.
19, 20. Brachial (19) and pedicle (20) views, X1.5, locality 6, OSU 51099.
21. Cardinal plate, X7, locality 6, OSU 51125.

22-38. *Anthracospirifer leidyi* (Norwood & Pratten), locality 6.

22-24. Brachial (22), pedicle (23), and posterior (24) views, X1, OSU 51101.
25-27. Brachial (25), pedicle (26), and right-lateral (27) views, X1, OSU 51100.
28. Brachial view, X1, OSU 51105.
29-31. Brachial (29), pedicle (30), and anterior (31) views, X1, OSU 51102.
32, 33. Brachial (32) and anterior (33) views, X1, OSU 51103.
34-36. Brachial (34), posterior (35), and right-lateral (36) views, X1, OSU 51104.
37, 38. Brachial (37) and pedicle (38) views, X1, OSU 51106. Note *Spirorbis* on *37*.

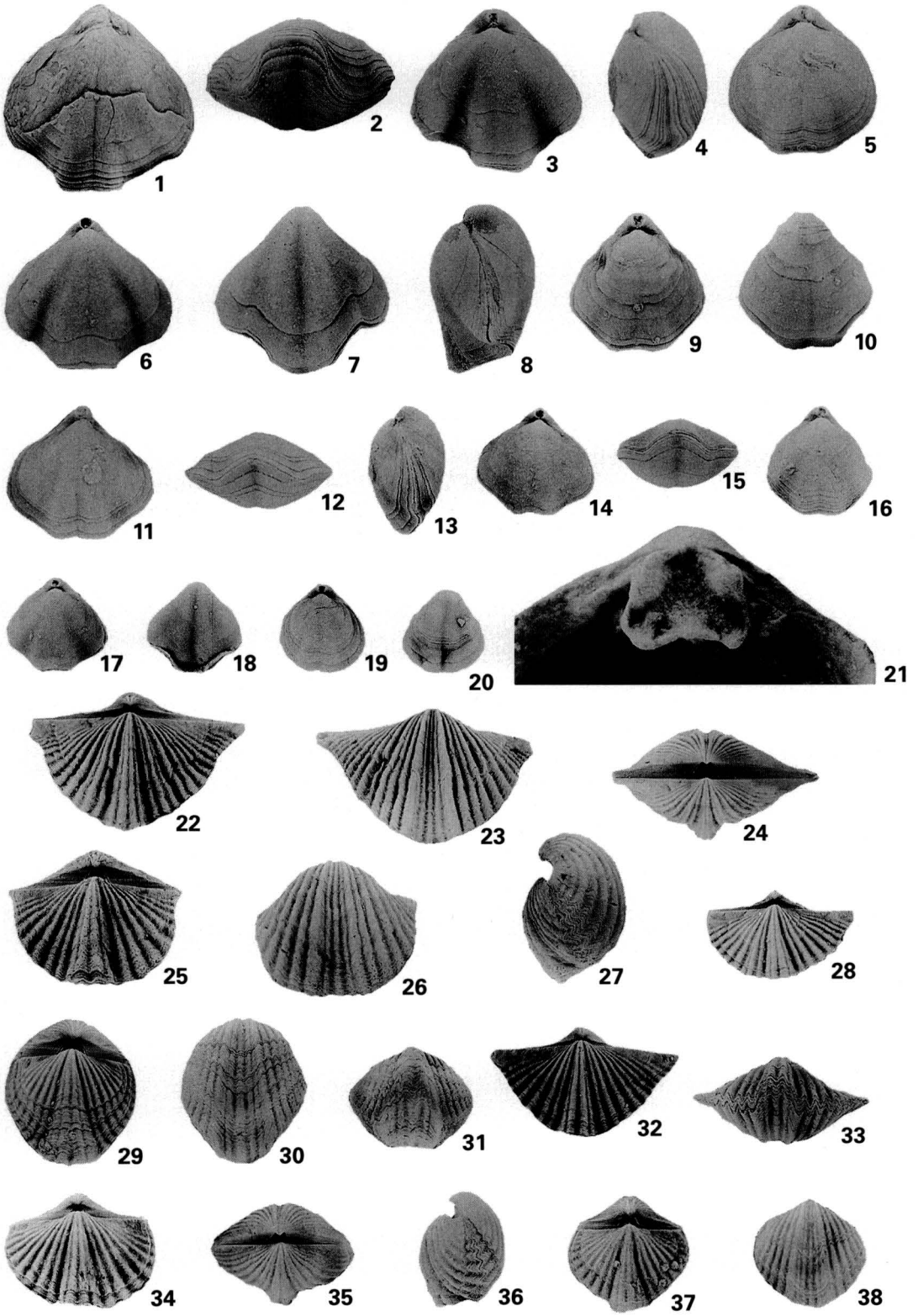
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PLATE 5

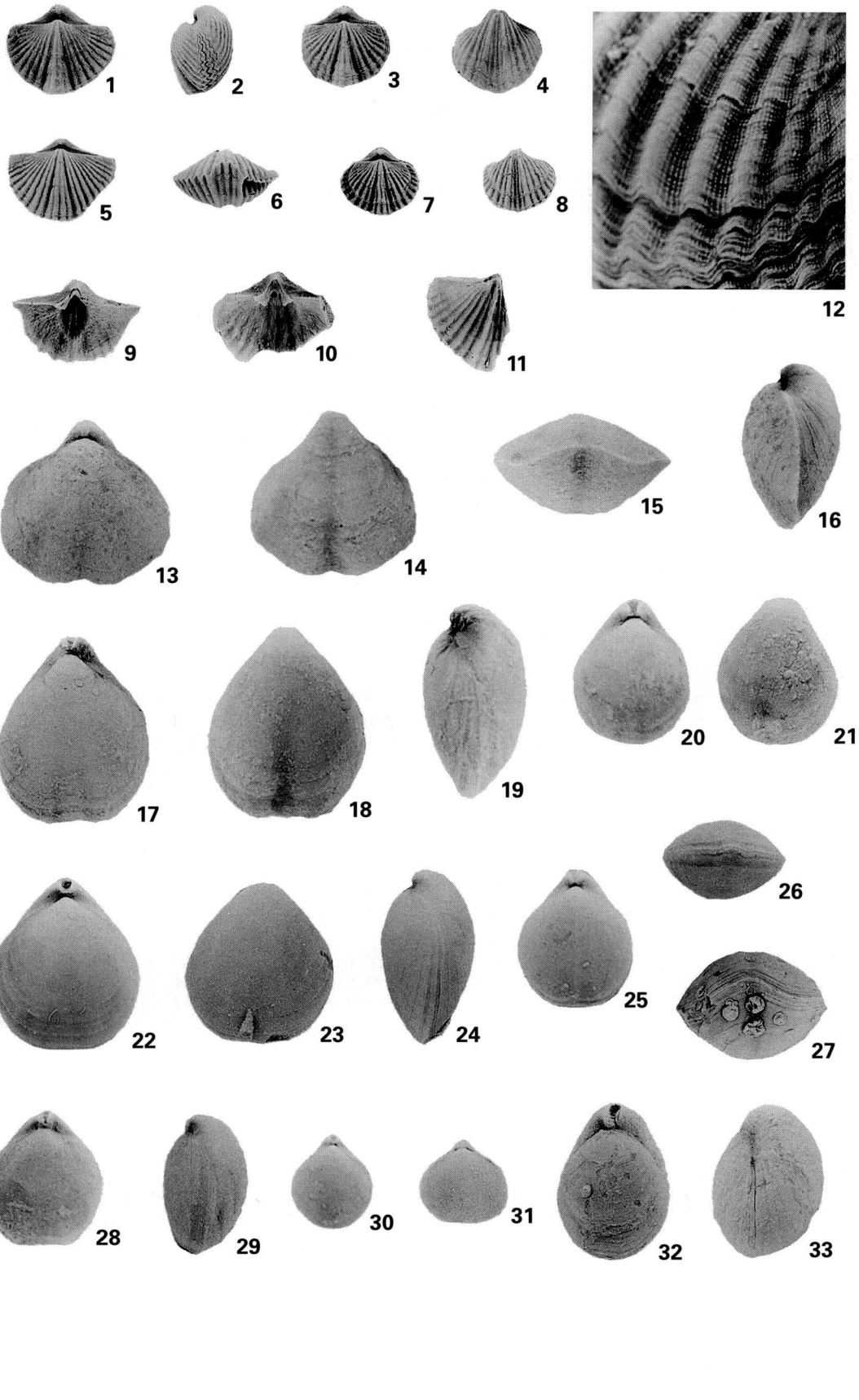
FIGURES 1-12. *Anthracospirifer leidyi* (Norwood & Pratten), locality 6.

1, 2. Brachial (1) and right-lateral (2) views, X1, OSU 51109.
3, 4. Brachial (3) and pedicle (4) views, X1, OSU 51108.
5, 6. Brachial (5) and anterior (6) views, X1, OSU 51110.
7, 8. Brachial (7) and pedicle (8) views, X1, OSU 51107.
9. Interior of pedicle valve, X1, OSU 51111.
10. Interior of pedicle valve, X1, OSU 51112.
11. Interior of brachial valve, X1, OSU 51113.
12. Micro-ornament, X8, OSU 51102.

13-16. *Torynifer setigera* (Hall, 1858). Brachial (13), pedicle (14), anterior (15), and right-lateral (16) views, X2, locality 15, OSU 24506.

17-33. *Girtyella indianaensis* (Girty).

17-19. Brachial (17), pedicle (18), and right-lateral (19) views, X2, locality 1, OSU 51114.
20, 21. Brachial (20) and pedicle (21) views, X2, locality 1, OSU 51119.
22-24. Brachial (22), pedicle (23), and right-lateral (24) views, X2, locality 1, OSU 51115. Note *Cornulites* on *23* and *24*.
25, 26. Brachial (25) and anterior (26) views, X2, locality 1, OSU 51118.
27. Anterior view, X2, locality 6, OSU 51091. Note *Spirorbis*.
28, 29. Brachial (28) and right-lateral (29) views, X2, locality 1, OSU 51117.
30. Brachial view, X2, locality 1, OSU 51120.
31. Brachial view, X2, locality 1, OSU 51121.
32, 33. Brachial (32) and right-lateral (33) views, X2, locality 6, OSU 51116.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